(2)

DESIGN AND IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT IN A CIVIL ENGINEERING SQUADRON

THESIS

Robert M. Wertz
First Lieutenant, USAF

AFIT/GEM/LSM/89S-19

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information is contained therein. Furthermore, the views expressed in the document are those of the author and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the United States Air Force, or the Department of Defense.

AFIT/GEM/LSM/89S-19

DESIGN AND IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT IN A CIVIL ENGINEERING SQUADRON

THESIS

Presented to the faculty of the
School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Engineering Management

Robert M. Wertz, B.S.
First Lieutenant, USAF
September 1989

Table of Contents

	page
Acknowledgements	ii
List of Figures	vi
List of Tables	vii
Abstract	viii
I. Introduction	1
Purpose and Overview	2
Background	3
Operations Objectives	4
General Issue	6
Total Quality Management Objectives	6
Research Problem	11
Investigative Questions	11
Scope	12
Limitations	13
Justification	14
Summary	15
II. Methodology	17
Overview	17
Case Study	17
Quality Questionnaire	20
Validity	21
Reliability	21
The Statistical Test	22
Determining Sample Size	23
T-Test	26
Assumptions	26
Chapter Summary	27
III. Literature Review	28
Chapter Overview	28
TQM Defined	28
Obstacles To Achieving Total Quality	30
Implementation Plan	31

page

Quality Plan Development..... 33
Step 1: Obtain Top Management Commitment..... 33
Step 2: Develop A Vision..... 34
Step 3: Form An Implementation Team. 35
Step 4: Develop A Policy Statement.. 35
Step 5: Develop Objectives and Guidelines..... 35
Step 6: Review Current Programs and Projects..... 38
Step 7: Develop and Implement a Formal Review Process..... 39
Tactics..... 39
Overview..... 39
Process Analysis..... 40
Job Characteristics and Worker Motivation..... 42
Job Dimension Considerations..... 43
Quality Indicators..... 43
Statistical Process Control..... 46
Just-In-Time Inventory Control..... 47
Federal Government Efforts In TQM..... 50
Summary..... 51

IV. Case Study..... 54

Overview..... 54
QP4..... 54
Inception: Indoctrination, Selling, and Training..... 56
Indoctrination..... 57
Education and Training..... 58
Strategic Planning..... 60
Squadron Quality Committee..... 60
Action..... 65
PAT Contract..... 67
Team Leaders..... 67
Recorder..... 68
Individual Members..... 68
Code of Conduct..... 68
Team as a Group..... 69
Quality Circles..... 71
Chapter Summary..... 72

V. Results and Discussion..... 73

Chapter Overview..... 73

page

Quality Questionnaire Survey..... 73
Data Analysis and Results..... 74
PAT Reports..... 77
Performance Awards PAT..... 78
HVAC Response PAT..... 81
Lessons Learned..... 88

VI. Conclusions and Recommendations..... 90

Conclusions..... 90
Suggestions..... 92
Recommendations For Further Research..... 94
Hawthorne Effect..... 94

Appendix A: Functional Duties of CE O&M Sections and Units..... 96

Appendix B: PAT Team Leader Duties..... 101

Appendix C: QC/PAT Meeting Minutes..... 102

Appendix D: Contract For Employee Involvement Groups.. 103

Appendix E: Process Action Team Problem Solving Process 104

Appendix F: Summary of the Primary Duties of the Facilitator..... 105

Appendix G: Quality Questionnaire..... 106

Appendix H: Performance Award Checksheet..... 111

Appendix I: Affected and Control Group Means and T-Test Results..... 112

Bibliography..... 114

Vita..... 117

List of Figures

Figure		Page
1.	CE Operations Branch Organizational Chart.....	5
2.	Likert Scale Example.....	21
3.	Model of the Effect of Job Characteristic	42
4.	Variables To Measure In Determining Progress of Implementation of Total Quality Management Practices.....	45
5.	Graph of Means By Categories.....	75
6.	Goals of the Performance Award PAT.....	80
7.	HVAC Response Problems and Initial Solutions: Procedure.....	84
8.	HVAC Response Problems and Initial Solutions: Materials.....	84
9.	HVAC Response Problems and Initial Solutions: People.....	85
10.	HVAC Response Problems and Initial Solutions: Equipment.....	85
11.	HVAC Response Implementation Strategies.....	86
12.	Steam Trap and Heat Plant PAT Objectives and Results.....	87

List of Tables

Table		Page
I.	Process Action Team Listing, WPAFB CE Squadron, 1989	78
II.	Performance Award PAT: Brainstormed Deficiencies.	79
III.	HVAC Response PAT: Brainstormed Deficiencies	82
IV.	HVAC Response PAT Pareto Analysis	83
V.	Observed Process Action Team Benefits	91
VI.	Suggestions For Further TQM Implementation	93

Abstract

The purpose of this study was to examine and document Total Quality Management (TQM) in a Civil Engineering squadron to improve quality and productivity of services and goods produced. This study was meant to provide a model demonstrating TQM implementation, as well as lessons learned, applicable to any other governmental organization (especially Civil Engineering squadrons) who desires organizational and productivity improvements.

In addition to the case study, a "Quality Questionnaire" survey was administered to employees at all levels to determine quality perception changes due to the TQM implementation. The study found that out of 6 main categories measuring quality, 5 of the six showed statistically significant increases in quality perceptions. In fact, the only category which failed to show an increase was "Internal and External Quality Results"; however, this was to be expected, since the TQM process improvements have improved quality and efficiency of processes, but not enough time has passed to actually observe significant changes in product quality.

TQM stresses employee participation-- something that Japan has been successful with for decades, while actual participative management is still a relatively new and

growing concept to American industry and governmental functions. This study reported several gains from employee participation. Indeed, tapping the ceative intelligence and expertise of hundreds throughout a field demonstrated the potential to vastly improve processes, increasing the quality of goods and services of the organization.

DESIGN AND IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT IN A CIVIL ENGINEERING SQUADRON

I. Introduction

Total Quality Management (TQM) is a management strategy whose objectives are to maximize quality and productivity by striving to continually improve work processes (35:5). The Office of the Deputy Secretary of Defense for TQM provides an exhaustive description of TQM:

> Total Quality Management (TQM) is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization. TQM is the application of quantitative methods and human resources to improve the material and services supplied to an organization, all the processes within an organization, and the degree to which the needs of the customer are met, now and in the future. (13:4)

The end goal of TQM is to maximize quality, timeliness, and the efficiency of services. Attributes of TQM include the following:

1. Top management is vigorously committed to quality/productivity as evidenced in daily practical management tactics.

2. A customer orientation permeates the agency, the needs and requirements of both internal and external customers are sought, and the level of satisfaction with the service becomes the basis of improvement efforts.

3. Teamwork at all levels is seen as key to improving processes and services.

4. Quality management and improvement training are provided at all levels of the agency.

5. Accountability for quality and productivity improvement is tied to managers' performance evaluations.

6. Recognition and incentive programs are established throughout the agency, targeted at service improvement efforts, and used creatively.

7. Productivity and quality measures are established and high standards are set for quality service delivery in all programs.

8. Barriers to productivity and quality improvement are eliminated or reduced.

9. Agency personnel are constantly stimulated to improve quality and productivity (communication, workshops, newsletters, bulletin boards, contests) (5:39).

Purpose and Overview

Total Quality Management is a vehicle by which agencies of the Federal Government and components will continuously improve all work processes. TQM presents gains in quality, efficiency, and productivity, inherently allowing the accomplishments of "more with less". In light of the present economic conditions, the Department of Defense (DOD) must become more efficient and productive, maximizing resource utilization. Therefore, this thesis demonstrates the implementation of TQM in a Civil Engineering (CE) squadron, providing guidelines for planning and coordinating TQM implementation, as well as "lessons learned".

One intention of this thesis was to document the implementation process so that future TQM implementations

in governmental, and especially Civil Engineering, organizations may benefit from the mistakes and successes of this initial TQM implementation. Moreover, by demonstrating TQM as a viable management program which improves quality of goods and services, other DOD components may be influenced to implement TQM.

Background

> The mission of Air Force Civil Engineering (AFCE) is to provide the necessary assets and skilled personnel to prepare and sustain global installations as stationary platforms for the projection of aerospace power in peace and war. (9:83)

Simply put, AFCE is responsible for the design, construction, modifications, operation, maintenance, and disposal of all Air Force real property (i.e., land, structures, pavements, utilities, and associated systems).

AFCE is a very large business. There are 150 major USAF bases and some 3200 sites and installations. The Air Force owns over 11 million acres of land, a physical plant that initially cost over $117 billion, and has an estimated replacement cost of over $580 billion, as well as 145,000 family housing units (18:1-2).

The Civil Engineering Operations and Maintenance (O&M) Branch basically performs all the craft labor necessary to carry out Civil Engineering's mission; consequently, O&M is the largest branch in CE. Air Force Regulation 85-2, Civil Engineering and Operations Branch, states that

the overall objective of the CE Operations and Maintenance Branch is to ensure that Air Force installations are capable of supporting the installation's mission, and to develop and implement programs to improve the livability of base communities.

Operations Objectives

Four achievements are necessary to support the Civil Engineering Operations and Maintenance Branch's objectives.

1. Mission Support: Ensure effective and efficient support of the installation mission. An example of a result of mission support is to maintain sufficient capability to correct any emergency condition 24 hours per day.

2. Customer Service: Maximize customer satisfaction. An example includes providing service to the customer on time with high quality workmanship to ensure full customer satisfaction.

3. Productivity: Utilize as efficiently as possible the Base Civil Engineering resources. An example of maintaining CE productivity is to adhere to correct engineered performance standards as much as possible.

4. Logistics Support: Maintain the logistics support necessary to enhance workforce productivity. An example is to maintain correct inventory levels of supply items (10:4-8).

AFCE Operations and Maintenance branches typically consist of seven major sections: Logistics; Requirements (divided into Production Control and Planning Units); Structures; Electrical; Systems Management; Pavements and

Grounds; and Mechanical sections. Several work shops fall under these branches. An organizational breakout of the Operations branch at WPAFB is provided.

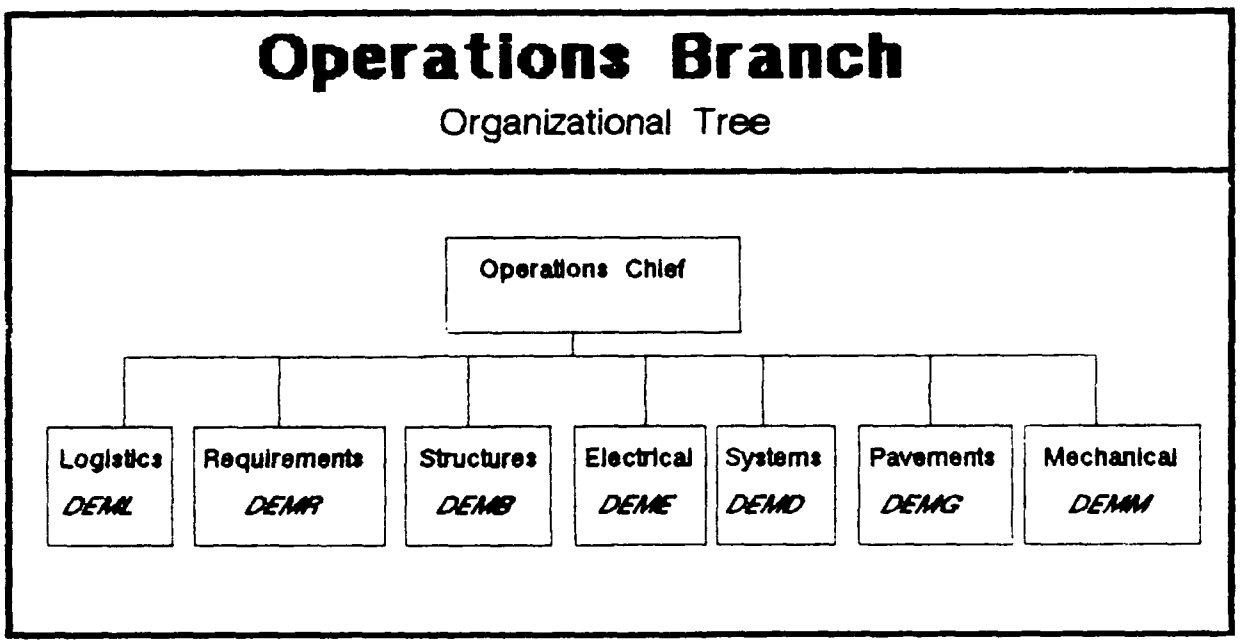

Figure 1. CE Operations Branch Organizational Chart

The above figure only shows the main sections that comprise the CE Operations and Maintenance Branch; all the smaller sections made up of the individual shops have been left out for simplicity.

The functional duties of the Operations Branch are multifarious, and best explained by examining and understanding the functional statements of the Operations Branch and the sections and units contained within the Operations Branch. For a detailed summary of these functional statements, refer to Appendix A.

General Issue

Total Quality Management Objectives. The overall objective of Total Quality Management (TQM) is to increase quality and productivity in an organization producing goods and/ or services. The main thrust behind TQM is to constantly plan and implement improvements in all work processes, anticipating and preventing defects before they occur. Thus, costly mistakes are prevented before they cause wasted resources.

The TQM environment encourages each employee to participate in setting and maintaining goals that relate to the quality of work being performed by the employees.

> Successful TQM implementation depends on establishing a nuturing, encouraging environment, a disciplined organizational goal-setting methodology, and a formal, structured process improvement methodology. (13:1)

The following list details eleven objectives of the TQM program:

1. Improve use of limited resources and reduce waste.
2. Preclude programs impacting manpower actions such as furloughs, hiring freezes, grade restrictions, performance bonus reductions.
3. Provide atmosphere that will improve employee job satisfaction.
4. Establish attitudes of ownership.
5. Improve customer satisfaction.
6. Provide atmosphere that will stimulate creativity.

7. Improve horizontal and vertical lines of communication.

8. Create loyalty and sense of commitment.

9. Promote trust between labor and management.

10. Quality concepts and techniques learned through Process Action Teams, Quality Circles, and other training sessions can be applied to solving everyday problems. (Process Action Teams are personnel chosen by management who meet periodically to discuss, analyze, and resolve work-related problems.)

11. Promote good, sound business practice. (39:2)

In 1988, the U.S. Federal Government officially mandated Total Quality Management implementation in all Department of Defense organizations to improve quality and productivity. Then Secretary of Defense Frank Carlucci wrote:

> I am giving top priority to the DOD TQM effort as the Vehicle for attaining continuous quality improvement in our operations, and as a major strategy to meet the President's productivity objectives under Executive Order 12552. (14:1)

In compliance with this Federal decree, the DOD stated:

> Total Quality Management is a DOD initiative for continuously improving its performance at every level, in every area of DOD responsibility. TQM must be focused upon continuously striving to improve all DOD processes. (14:1)

DOD Directive 5000.51 Total Quality Management: A Guide For Implementation established policy and assigned responsibilities regarding TQM implementation in the DOD. DOD policy stated that,

1. Each DOD Component will implement a TQM plan that contributes to the overall DOD TQM process.

2. Managers at all levels will provide leadership and integrate TQM principles into their daily activities and functions. Continuous improvement must be fostered in all aspects of DOD operations, including administrative, service, tactical operations, engineering, manufacturing and logistics.

3. Managers will ensure that all employees are properly trained and motivated in the TQM principles.

4. Managers will remove barriers and create a working environment that encourages creativity, cooperation, and use of statistically based decision making.

5. TQM principles of high quality, continuous improvement, cost reduction, and improved schedule performance are given primary consideration in all decisions.

   a. Continuous process improvement focused on all phases of a product's life-cycle will be a principle objective of all operations in all processes.

   b. Quality concepts will be applied as early as possible in the life-cycle as an economical means to prevent more costly problems later in the life cycle.

   c. Suppliers of products and services to the DOD will be encouraged to implement TQM principles within their organizations to improve the quality of the products and services they provide to the DOD.

6. The concepts of TQM will be inherent in all Department of Defense activities. (12:2)

The following TQM concepts relating to DOD were provided.

1. Quality is absolutely vital to our defense, and requires a commitment to continuous improvement by all DOD personnel.

2. Sustained DOD emphasis and concern with respect to high quality and productivity must be an integral part of our daily activities.

3. Quality improvement is the key to productivity improvement and must be pursued with the necessary resources to provide tangible benefits.

4. Emphasis must change from detecting defective products to improving design and manufacturing processes, thus preventing defective products from occurring.

5. Management and personnel at all levels must take responsibility for the quality of their work.

6. Systematic impediments to the implementation of TQM must be identified and removed.

7. Principles of quality improvement must involve all personnel and products. (12:4)

The Air Force is working in accordance with this Defense Department TQM directive. Air Force Logistics Command (AFLC) is taking an especially active approach to implement TQM in all AFLC organizations. AFLC commander General Alfred Hansen identified the requirement to develop and implement TQM in all AFLC organizations:

> It became very obvious that we had fallen into the same pit everybody in the United States of America had fallen into-- we needed to build quality into every one of our processes. It's time Americans start realizing the importance of quality and make sure our products are the best there are-- by implementing Total Quality Management, we can do just that. (22)

AFLC's TQM philosophy was stated.

> Quality must be built in by concentrating on each step or process involved in delivering products to customers instead of merely inspecting the final product or service. AFLC recognizes that the worker usually knows better than his supervisor how to improve the quality of output. Consequently, management's primary contribution to quality improvement in AFLC will be to create and maintain an environment where employees are encouraged and helped to improve their processes. (4:2)

AFLC's Total Quality Management program strives to achieve top quality via the implementation of "QP4". QP4 stands for achieving quality through people, process, performance, and product (4:4). Chapter 3 provides a comprehensive review of QP4.

Air Force Civil Engineering is a governmental component which intends to implement TQM in the near future at all of the Air Force bases. Thus far, several program managers at the Air Force Engineering and Services Center, Tyndall AFB, FL, have attended TQM seminars to aid in planning TQM implementation in Civil Engineering.

There is much to be gained in AFCE by implementing TQM, as many quality and productivity problems exist in Air Force Civl Engineering. Capt Michael J. Pincinse, Chief of Operations and acting Base Civil Engineer, Gunter AFB, Alabama, identified current CE quality and productivity problems:

> Something needs to be done to improve quality and productivity in today's Civil Engineering Operations branches. For one, updated improvements in scheduling are needed, making use of contemporary procedures used in the private sector. Secondly, quality control is practically nonexistent. There are no lower-level reponsibilities- craftsmen can perform their tasks without being accountable for them. If people are not accountable for their work, why should they be interested in quality? (29)

Research Problem

Current TQM literature asserts that numerous gains may be accomplished by implementing Total Quality Management in both product and service oriented organizations. Top Department of Defense leaders, including the Secreatary of Defense, asserted the need for quality and productivity improvements in all DOD organizations. Civil Engineering is one such DOD organization which may benefit from TQM. Civil Engineering is mainly a service organization, whose main objectives include satisfying the customer. Above all, TQM stresses the importance of striving at all levels to satisfy the customer, whoever the custmer may be.

The objective of this research was to document the implementation of a Total Quality Management program tailored to the Wright Patterson AFB CE Operations Branch. Moreover, a survey instrument which measured employee perceptions of organizational quality was utilized to measure changes in the Squadron's organizational attitudes towards quality that occurred due to the TQM efforts.

Investigative Questions

Answers to certain specific research questions are needed to properly analyze and document this case study. The following research questions pertain to the design and implementation of this Total Quality Management program:

-- What is a Total Quality Management program?

-- Why was the Total Quality method chosen?

-- How was Total Quality Management implemented?

-- How were Process Action Teams chosen and utilized?

-- How was top management's support of the Total Quality Management's program shown and publicized?

-- How was strategic planning performed to support the TQM efforts?

-- How were productivity and quality to be measured?

-- How were quality of service and products improved?

-- How were autonomous work teams being used? For example, a group consisting of programmer, designer, draftsman, procurement officer, and construction manager may be more effective working in tandem than in separate, disconnected efforts.

-- How were management information systems utilized?

-- How were customers' expectations being met or exceeded?

-- How were Just-In-Time or other inventory control methods utilized?

Scope

This study focused on documenting Total Quality Management implementation in the Wright Patterson AFB CE Operations Branch, then measuring employee attitudes to determine changes in organizational quality. An

investigation into the recommendations of contemporary experts regarding how TQM should be developed and implemented was required, and was documented in the literature review, providing goals and guidelines toward design and implementation of the TQM program.

Typical Air Force CE organizations consist of seven branches in addition to the Operations & Maintenance Branch. These additional Civil Engineering branches are Readiness, Squadron, Family Housing Management, Fire Protection, Financial Management, Industrial Engineering, and Engineering and Construction. While all of these branches can and will implement TQM, this study was directed at the design and implementation of TQM in the Operations and Maintenance Branch. Operations was chosen since it is has the largest directly controllable work force in a typical Air Force Civil Engineering Squadron (29). Moreover, the Operations and Maintenance branch of Civil Engineering is continually under public scrutiny-- the Operations Branch's work is very critical to satisfying CE customer expectations.

Limitations

Time was the major limitation, for numerous reasons. The first is that TQM implementation is actually a never-ending process. The Total Quality Management method should continually grow and evolve, bringing about

further improvements in work-related processes and employee participation. "It is expected that 3 years is an average time period to expect to see valid accomplishments and quality improvements from TQM" (13:5).

The second reason that time was a limitation of this research is that in order to measure substantial quality improvements, more time than a mere nine months is required. However, the intention of this research was to implement the TQM program, and observe and measure improvements in quality within the nine month period.

The second major limitation of this research project is an inherent limiting characteristic of all case studies: knowledge gained may not necessarily be completely applicable to all CE Operations and Maintenance Branches throughout the Air Force. Whatever uniqueness or peculiarities that may exist within the Wright Patterson AFB Operations Branch may cause the model to be only partially usable at another Air Force Operations Branch, or similiar organization.

Justification

Although numerous publications are available through the Defense Technical Information Center search services concerning TQM, none were available that specifically reference implementation in a Civil Engineering organization. While partial descriptions of Total Quality Management programs in government organizations are

available,the organization and management of these programs may be significantly different from what the TQM program for Civil Engineering would be, just as a Civil Engineering Squadron is inherently different from other organizations in mission and structure.

This case study is meant to provide a model demonstrating the implementation of a revolutionary new participative management method that any Air Force CE organization can use to improve the productivity and quality of its goods and services. Moreover, this thesis details accomplishments in Total Quality Management that can be examined and communicated to other similar military organizations. Finally, this research project provides a detailed study of the management techniques and applications of Total Quality Management, building a solid foundation upon which others may build.

Summary

Total Quality Management is described as both a management philosophy and a set of guiding principles which stress continuous process improvements to achieve gains in quality and productivity. TQM implementation in all Federa. Government organizations is directed by the Secretary of Defense. The DOD and the Air Force are committing themselves to comply with the directive, focusing on increasing quality and productivity in all DOD components.

This research documents TQM implementation in the Operations and Maintenance branch of the WPAFB Civil Engineeering squadron. Time was the major limitation. TQM implementation really never ends. However, this study had to be completed within one year, as dictated by AFIT. Thus, the TQM program was still in its infancy when this case study was written.

II. Methodology

Overview

In general, this thesis is a case study documenting TQM impelementation in the WPAFB CE squadron. The author of this thesis and the CE Industrial Engineering Branch acted as the facilitators of the implementation. A Quality Questionnaire survey measured perceived quality 12 months following the beginning of the TQM implementation in a "control group" and an "affected group" to reflect organizational attitude changes towards quality. A baseline measure was not taken prior to the beginning of the TQM implementation since the measurement survey was undergoing development throughout a cross-section of AFLC organizations. The instrument was completed 12 months into this research project.

The Quality Questionnaire was used to provide quantification or proof that the TQM implementation had an effect on the organization. However, the true purpose of this research project was to document implementation of the Total Quality Management program, not to experiment to determine changes in quality due to new quality management strategies.

Case Study

The overall research method used to solve the specific problem statement was a case study of the Total Quality

Management implementation at the Wright Patterson AFB CE Operations and Maintenance Branch. The basic purpose of a case study is to generate hypotheses which may be generalizable through intense examination of a single unit (18:136). The benefits of a case study include the following:

-- The case study allows for "flexibility" in data collection. The researcher has considerable discretion over not only the type of data gathered, but also over sources from which information is obtained, such as interviews, observations, and documentary material.

-- It allows the presentation of "evidence" on what the researcher considers to be a rare, remarkable, or a typical instance of some phenomenon.

-- The case study can be used to establish a pool of data that may be useful at a future point in time (32:136-137).

Problems or disadvantages of using a case study as a research methodology include the following:

-- Data obtained on a single unit may be used as a base for generalizations, but not prove general conclusions about larger populations.

-- It is the least systematic of all research methods.

-- Data collection may alter the setting under study.

-- Most importantly, results of case studies are likely to have substantial amounts of bias because of nonsystematic collection, condensation, and interpretation of data (32:136-137).

To minimize inherent weaknesses in this case study, a systematic, stepwise approach was used to perform an

objective, accurate, and comprehensive review of the program. An attempt was made to quantify actual employee attitude changes towards quality, providing statistical proof of TQM affects.

Normally in a case study, the researcher conducts an intensive, thorough examination of a single unit. However, in this project the researcher was directly involved in the TQM program's design and implementation, rather than analyzing a single unit from a detached viewpoint. The major consequence of this method was that the researcher needed to be constantly aware of maintaining objectivity as he critically examined the project throughout the implementation process. The main benefit of the researcher working internally throughout the TQM implementation was that the researcher was privy to all subtle or indirect problems or benefits that may or may not have otherwise been apparent.

The following steps were taken in support of the research project:

1. Researched all applicable and contemporary literature regarding Total Quality Management.

2. Obtained permission from the Wright Patterson AFB Civil Engineering commander to work with the Industrial Engineering branch as a facilitator in the TQM implementation.

3. Coordinated with the Wright Patterson AFB Industrial Engineering branch to design and develop Total Quality Management strategies tailored to the Base CE Operations Branch.

4. Implemented, observed, measured, and documented the Total Quality Management implementation.

5. Administered the Quality Maturity Instrument to obtain a measurement of worker attitudes and perceptions toward quality in the organization, both of a treated group and an untreated group.

Quality Questionnaire. In addition to the case study, it was desired to obtain a measurement of changes in worker attitudes and perceptions towards quality in the organization. To provide such a measurement, the "Quality Questionnaire" survey, developed in a master's thesis by Ruth Scneider and Capt Edward Hayner at the Air Force Institute of Technology, was administered 12 months into the Total Quality Management program's implementation. This "Quality Questionnaire" provided a measurement of changes in worker perceptions of organizational quality. Two groups were queried; the first group (the control group) consisted of an untreated group of CE Operations workers. The second group consisted of employees who were exposed and involved with the Total Quality Management implementation.

The Quality Questionnaire was a survey consisting of 54 questions designed to determine employee attitudes and perceptions of organizational quality. These 54 questions were organized into 6 different blocks: leadership, strategic quality planning, human resource management, quality assurance of products and services, quality results, and customer satisfaction. These six areas measured by the

survey were further broken out, as can be observed by examining the survey (see Appendix G).

The survey quantified employee responses using a seven point Likert scale, as in the following sample:

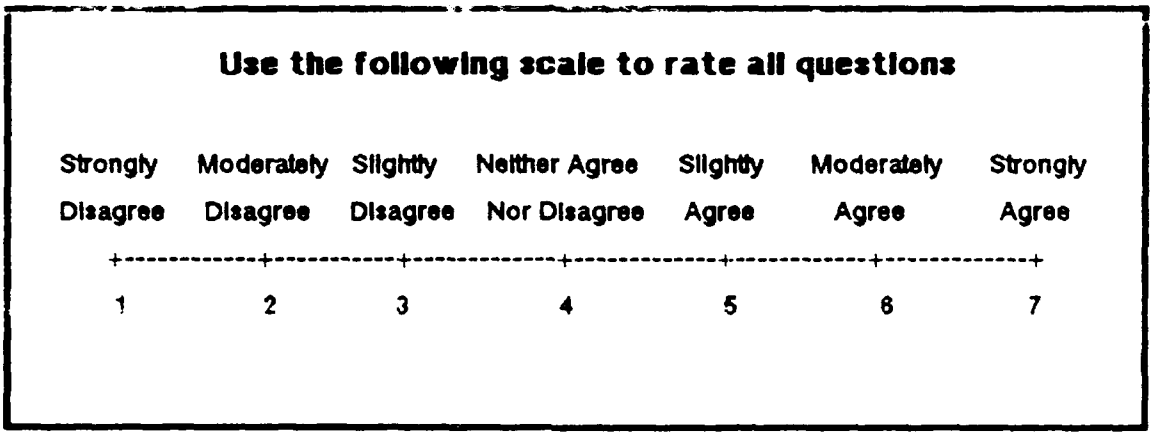

Figure 2. Likert Scale Example.

Validity. The Malcom Baldridge Award is annually awarded to a company who has made the most gains in quality of products and services. In order to determine categories to measure for the award, 400 quality "experts" were queried by the Delphi method. The subjects measured in the Quality Questionnaire were as determined by the 400 experts to be most critical in measuring organizational quality, testifying to the content validity of the instrument. Moreover, the Quality Questionnaire was developed after being pretested and tested throughout 35 AFLC organizations to ensure validity and reliability.

Reliability. The reliability of a measure refers to its trustworthiness, addressing the repeatibility,

stability, or consistency of the measure. The reliability coefficient, typically obtained through the use of the correlation coefficient r, indicates the consistency of the obtained scores (40:282). All areas of the Questionnaire were determined reliable using a crownbach alpha reliability statisitic, where the least crownbach alph was a relatively high .79.

The Statistical Tests. Two groups were sampled to determine employee attitudes toward organizational quality according to the employee's experiences and perceptions. Sample sizes consisted of thirty personnel per group. The first group consisted of randomly selected personnel throughout the organization at various worker and managerial levels who had significant experience with the organization's quality program. At a minimum, these personnel typically participated in one or more Process Action Teams or Quality Circles. The second group consisted of randomly selected personnel throughout the organization at various worker and managerial levels who had little or no significant experience with the organization's Total Quality Management program. These "control group" personnel obviously were aware of the TQM implementation being conducted both within the Civil Engineering organization and outside of the organization, or throughout the entire AFLC Major Command. However, due to the relative immaturity of the program

thus far (in accordance with the literature, a TQM program requires at least 5 years to nearly reach maturity) it was assumed that the control group was essentially unaffected by the TQM implementation.

Determining Sample Size. First some basic statisitical terms are clarified to aid the discussion. In testing statistical hypothesis, the problem is formulated so that one of the claims is initially favored. This initially favored claim will not be rejected in favor of the alternative claim unless sample evidence contradicts the initially favored claim and provides strong support for the alternative assertion. The claim initially favored or assumed true is called the *Null Hypothesis*. Conversely, the alternative claim in a hypothesis testing problem is termed the Alternative Hypothesis (16:278).

A Type I error occurs when the Null Hypothesis is incorrectly rejected. A Type II error involves failing to reject the Null Hypothesis when, in fact, the Null Hypothesis is indeed false. Beta is said to be the probability of making a Type II error. Therefore, it follows that 1-Beta (the Power of the test) is the probability of correctly rejecting the false hypothesis (24:185). Now that the basic statistical terms have been introduced, the logical question is, how is power calculated?

Determining the power of a particular statistical test requires the values of four factors influencing Beta: 1) how far the true mean deviates from the hypothesized mean; 2) the significance level (alpha) and whether the test is one-tailed or two-tailed; 3) standard deviation of the sampled population; and 4) sample size "n" (power increases as "n" increases). The four parameters are so related that when any three of them are fixed, the fourth is absolutely determined (7:153).

When drawing a sample from a population in order to test a hypothesis about a particular population parameter, it is important to have a powerful test. However, the only two factors controllable by the researcher that influence the power of a test are sample size n and significance level alpha. Since there is no concurrent concern of committing a Type I error, the variation of alpha is restricted, leaving sample size "n" as the only variable under the researcher's control to increase the power of the test (16:189).

In this study, a 100 percent response rate was realized from employees who completed the Quality Questionnaire. Due to the 100 percent response rate, statistical inferences may be made with at least 95 percent confidence (37:289). Therefore, the standard 95 percent significance level was chosen, both for the sampling plan and for the t-tests themselves. In the sampling plan,

> This confidence/reliability level means that if many samples of the same size and format were to be drawn from the same population, 95 percent or more of the confidence intervals of the samples (± 5 percentage points) would contain the true population mean. (23:11)

Accordingly, for the one-tailed t-test at the 95 percent level, a p-value less than .05 is said to fall in the rejection region, signifying rejecion of the Null Hypothesis.

> The survey statistician will be 95 percent confident that the true population statistics lie somewhere within the interval + 5 percentage points from his achieved sample statistics for each question in the survey. (23:11)

The following general formula was used to compute the sample size for this research. This formuala is applicable when there is a known finite population, and the objective is to achieve the confidence/ reliability level of 95 percent ± 5 percent:

$$n = \frac{N(z^{**}2) \times p(1-p)}{(N-1)(d^{**}2) + (z^{**}2) \times p(1-p)} \qquad (23:13)$$

where

- n = sample size
- N = population size
- p = maximum sample size factor (.5)
- d = desired tolerance
- z = factor of assurance (1.96) for 95 percent confidence level.

The result of the above formula was to survey a sample of 30 personnel for each of the two groups, affected by the TQM program and not-affected by the TQM program.

T-Test. To determine appropriate statistical inferences, t-tests were conducted for each specific question from the Quality Questionnaire. The purpose of the t-tests was to determine if means of the Affected and Control Groups were significantly different. In cases of significantly different means, changes in employee attitudes and perceptions towards quality may be claimed.

Assumptions. Various assumptions were made to perform the t-tests. A discussion of the assumptions follows.

1. Assume independent, random samples.

2. Assume the samples originate from normally distributed populations. This assumption was verified with "rankit plots" of the data.

3. Assume equal variances. According to common statistical practice, when performing a t-test to determine difference between the means, the assumption of equal variances is relatively valid if the sample sizes of the two groups are equal (29:174). The statistical package used in this research also verified this assumption.

The Null Hypothsis was that there was no difference between the means, or mean employee quality perceptions were not statistically different between the control group and the "affected" group. The Alternate Hypothesis claimed significant differences between the means, which is to say that the "affected" group of thirty employees resulted in a statistically significant different level of quality perception than the control group. Statistical data and conclusions from the t-tests are given in Chapter 4.

Chapter Summary

The overall methodology for this research was a case study documenting TQM implementation at the WPAFB CE Squadron, specifically in the Operations and Maintenance Branch. In addition to this case study, a survey entitled the "Quality Questionnaire" was administered to determine modifications in employee attitudes toward quality in the organization. T-tests proved whether or not significant differences in perceptions toward quality had occurred. However, the true purpose of the statistical survey was not to overshadow the case study, but to quantify actual effects of the TQM implementation.

III. Literature Review

William Strickland, plant manager for Ford Motor Co. in St. Louis, defines quality.

> Quality is the value that your customer perceives he is receiving in the product or service he receives, not what we as the manufacturer perceive to be customer satisfaction. (34:16)

Chapter Overview

Every study is a search for information (19:135). This study incorporates the search and review of general information regarding Total Quality Management, Quality Control techniques, and Quality Assurance. More confidence can be placed in quality of the findings of a study if all sources relevant to the study have been explored (19:135).

Contemporary literature relating to Total Quality Management describes various aspects of a TQM program as well as recommendations by contemporary experts concerning TQM implementation. After describing TQM and the obstacles to implementing TQM, a "Quality Plan" outlining implementation steps is formed. Total Quality Management tactics, Just In Time Inventory Control methods, and Federal Government TQM efforts thus far round out this literature review.

TQM Defined

TQM is a focused management philosophy for providing the leadership, training, and motivation to continuously improve an organization's management and operations (4:16).

What distinguishes TQM from other quality improvement strategies is TQM's unflagging dedication to

1. Training.
2. Recognition of quality as the presence of value, not the absence of defects.
3. Management commitment and involvement.
4. A working environment where all employees seek continuous improvement.
5. Customer satisfaction (internal and external).
6. Quality awareness throughout the organization.
7. Long-term commitment to continuous improvement.
8. Rigorous analysis of all systems and processes.
9. Focus on preventing defects before they occur, rather than inspecting the finished product/ services.
10. Elimination of non-value added activity and reduction cycle time.
11. Involvement of all employees. (4:16)

Once a company has applied TQM principles, that company is said to have undergone the "quality transformation" (8:138). The organization that has implemented Total Quality Management exhibits the following characteristics:

1. Quality has become their uppermost goal.
2. Customer orientations have been adopted.
3. Inter-divisional barriers have been broken down.
4. Statistical methods have been used.
5. Participative management methods have been employed.
6. Cross-functional approachs have been used to solve problems (8:138).

Obstacles To Achieving Total Quality

Five major long-term challenges to federal agencies with respect to Total Quality Management follow:

1. Comprehensive quality improvement education must grow and be maintained.

2. Top management support must constantly be demonstrated.

3. Attitudes towards full customer support must be strong.

4. Measurement systems should be widely used and understood.

5. Needed investments for long-term gains may be scarce due to lack of commitment to TQM or budget problems (5:41).

Of these potential obstacles to achieving the goal of total quality, lack of top management commitment may be the most detrimental. Budgetary difficulties may be beyond the realm of control. However, without top management's continual drive and support, the TQM program will be shaky at best. When company leaders announce a change, the leaders themselves must undergo change; their change must be a clear demonstration to everyone of the importance of the quality transformation (20:27). "Employees will not convert from old ways to new ways without clear support from top management, even if the new way is obviously better" (20:27).

It is not uncommon for employees to demonstrate resistance to the quality transformation. Resistance

may occur beacause employees are forced to perform their work at the same time the changes are being attempted, and they may lack faith in the validity or fail to realize the importance of the new management style. Therefore, the tendency is to perform the tasks employing old, commonly used methods and reject the new changes.

> Change is difficult; resistance to change is often strong and persistant. No matter how much a company might want to transform itself to some new order, it must continue doing business and, for the time being, do so in the way it knows best. Transformation involves ... a shift from one way of being to a new way of being. (20:28)

Management is cautioned not to "sandwich" the TQM implementation into too short a time period:

> Moving too quickly in the improvement efforts when numerous changes are required creates a high level of stress and frustration in the work force. The goal is to aim the people, not to alienate them. (6:42)

Moreover, others warn not to expect the TQM progam to be implemented too fast:

> Change requires more than an authoritarian edict. For change to occur, time is needed, with incremental changes over a time period. In fact, the changes should be a process rather than an end result (20:29).

Implementation Plan

Contemporary literature on the subject of Total Quality Management provides many disjointed methods to improve organizational quality and productivity. However, practical, comprehensive guidelines and strategies

to help managers plan for and carry out the quality transformation are not as easily found. In the words of General Hansen:

> There's a lot of smart guys making the big dollars on quality right now. They're putting out this literature, but it's very difficult for people to pull it all together. (22)

The following four general guidelines to achieve quality in service industries outline the basics of a TQM implementation plan:

1. Provide services that satisfy customer needs and expectations. To do this, management must correctly identify the customer's needs and expectations, translate those expectations into required characteristics of the services to be performed, and establish service quality goals and targets.

2. Produce required services and products. Process complexities and chronic problems must be minimized. Moreover, attempts to correctly obtain desired outputs the first time must be demonstrated by all the employees in the organization.

3. Plan to utilize quality control in an effort to improve processes under operating conditions. Applicable quality control methods must be learned and used to properly implement this third step.

4. Pay special attention to features unique to the service industry. Minimizing customer waiting time and maximizing customer perceptions of how the workers perform their tasks are of utmost importance in improving quality of service (25:39-42).

Quality Plan Development

A quality plan of to implement TQM must follow the above guidelines. A quality plan is:

1. A philosophical framework supported by short and long-term quality based projects and programs that have an impact on business objectives.

2. The foundation of any business plan.

3. A necessity to ensure operational excellence (32:72).

A quality plan as described above must be designed and followed to properly implement Total Quality Management and overcome the aforementioned obstacles. Seven steps to properly implement a quality plan include:

Step 1. Obtain Top Management Commitment. Without top management commitment, there is no sense in even beginning TQM implementation, since it will be doomed to fail (32:73). TQM implementation is top-down driven, as documented on page 38 of this project. The following paragraph and quotations are examples of information which could be used to obtain top management commitment to the TQM implementation.

A common misconception in American industry today is that for an increase in quality, a corresponding decrease in productivity is realized. However, TQM theory holds that productivity and quality are positively related. Deming contradicts the myth that quality increases at the expense of productivity:

> For every quality improvement, costs decrease due to less rework, fewer mistakes, delays, snags, and better use of time and materials. Thus, productivity increases as a by-product of quality improvements. (6:41)

Step 2. Develop A Vision.

> The vision gives everyone in the organization something to shoot for, something they can share, and a way to take pride in accomplishments along the way. (32:73)

Ideally, the TQM-oriented company has adopted quality as its number one operating priority and leads the industry in customer satisfaction (32:73). From this perspective, there are two basic types of organizations: old and new. Old types of organizations refer to the proverbial "chain of command", while new types refer to a systems view of an organization.

> If you ask someone, "In your work, who is it important to please?" and if he or she answers "my boss", that person experiences the organization as the chain of command. If the answer is, "the people in the next step of the process, my internal customer, and our external customer, that person has a systems perspective. (20:29)

Leaders who view their organization as a chain of command will not be able to visualize their company as customer and quality-oriented, thus impeding the pursuit of quality (20:31).

Major approaches to sustained improvements in quality involve the following: (1) a focus on systematic rather than individual causes of poor quality, (2) the use of statistical methods as evidence of quality improvement actions and for

the assessment of their impact. (3) an emphasis on intra- and interdepatmental communication in solving and preventing problems, and (4) removal of defects through process improvement rather than inspection (8:134). Full scale adoption of these principles involves a major change in the organization's orientation toward the way work is conducted. For example, strong emphasis is placed on employee participation, systematic quantification of problems, data-based decision making, and minimizing fault-finding.

Step 3. Form An Implementation Team. The team should consist of the best people, since they will influence all levels of the organization, bring credibility to the TQM program, and people will perceive that the TQM program is important right from the start (32:73-74). From a functional point of view, a team led by someone from top management, composing of several individuals chosen from a cross-section of the organization would be appropriate.

Step 4. Develop A Policy Statement. Policy should give direction, rather than instructions. Management should take an active role in developing the policy, and demonstrate commitment to that policy (32:74).

Step 5. Develop Objectives And Guidelines. "Objectives are really at a higher level than guidelines, but they are related, since objectives cannot stand alone without guidelines" (32:74). The following nine "guidelines for

quality" detail actual changes which must occur within the organization in order to increase quality and productivity.

1. Quality begins with delighting the customers- the quality-oriented firm must give the customers even more than they imagined possible.

2. The quality organization must learn how to listen to customers and help customers identify and articulate their needs, as well as remain close to the customers and request customer feedback.

3. The quality organization leads customers into the future. Innovation to constantly improve the organization's products and services is a must.

4. Flawless, customer-pleasing products and services result from well planned systems and processes that function flawlessly. The quality- oriented organization must continuously strive to improve these processes and systems.

5. In the quality organization, the vision, values, systems and processes must be consistent with and complementary to each other. Systems and processes are the sequences of activities by which all work gets done. When systems and processes work at cross purposes, the result is waste and frustration.

6. Everyone in the organization must work in concert. This teamwork spirit must be strong enough to supersede the attachments that form from normal associations of profession, rank, or function.

7. Everyone must know his or her job. Employees must understand where their work fits into larger processes and systems of which they are a part, know what their internal customers want and do not want, and master the skills and information necessary to perform their tasks.

8. The quality organization must use data and the scientific approach to plan work, make decisions, solve problems, and pursue improvements.

9. The quality organization culture supports and nourishes the improvement efforts of every group and individual in the company. Objectives include being close to the customer, the importance of data and precision, internal teamwork and mutual respect, constant improvement, and pride of all work, including both processes and products (20:28-29).

The following top-down strategies demonstrate how to bring about necessary organizational changes required to begin the quality transformation. The first strategy is geared toward upper management. Top leaders must take the lead in the quality transformation, continually demonstrating total commitment to improving the systems and work processes, instead of looking for someone to blame. Also, top management appoints facilitators, who take an especially active role in the total quality effort. Facilitators instruct employees and seek new ways to integrate quality into all functions, such as planning, marketing, and controlling.

The second strategy is for management to develop a "blueprint" for the quality transformation. This blueprint should dictate who should be the point person for each specific area and how these persons will be trained. Moreover, the blueprint should detail the amount of preparation which is required, where to get technical assistance, and how middle management and supervisors can and will be supported. The third strategy authorizes management to establish and prioritize processes for the

internal coordination, oversight, and technical training and assistance needed to support the quality efforts.

The fourth strategy coordinates the deployment of in-house resources, arranging for proper training of key personnel, and coordinating publicity for the transformation efforts. Moreover, top management advises key members while keeping the long term vision in sight, and aids middle management in assessing the effects of the quality transformation efforts. This fourth strategy emphasizes that managers must undertake specific efforts to alter organizational culture in an effort to become more supportive toward the goal of producing total quality products and services.

Step 6. Review Current Programs And Projects. Determine what needs to be done to achieve the vision, support the policy, meet the objectives, and internalize the whole quality philosophy (32:75). The adoption of an organization-wide quality program may significantly impact the way that policies are carried out, resources used, and decisions made. Therefore, the implementation team must study and become familiar with how the organization carries out policies, makes decisions, and distributes and uses resources prior to implementing the TQM program. Knowledge of organizational policies and decision-making processes may be important later on during the TQM implementation,

and will be helpful in understanding organizational changes that occur due to the quality movement.

Step 7. Develop And Implement A Formal Review Process. Senior staff should routinely invite several of the project managers to present the program status, progress, issues, concerns, needs, and corrective actions. This produces visibility for the TQM program and helps the staff to stay in touch. Ongoing review of all key programs by a central board or committee is important (32:75).

Tactics

Overview. TQM demands and incorporates the use of several quality "tactics". Process analysis uses participative management to continually improve the quality of all work processes. To properly employ participative management, job characteristics theory and motivation must be understood and practiced. Quality indicators must be a part of any quality improvement effort, and are used in statistical process control.

The following objectives may be used as a guide when implementing the TQM program.

1. Needs assessment: identify target areas.
2. Data gathering: collect pertinent information.
3. Analysis: determine findings from collected data.
4. Action planning: make recommendations for implementation.
5. Follow-up and evaluation: assess the effectiveness of recommendations and implementation (6:41).

Process Analysis. Much of the current literature involving TQM emphasizes improvement through process control. It is important, therefore, to understand the interactive nature of the work processes, key processes, and outcome measures at one's disposal. This process analysis refers to studying and understanding the systematic nature of the work processes.

The key of this process analysis is to gather information concerning: (1) the ways work is conducted, (2) the existing and potential areas of measurement, and (3) areas requiring change if quality is to be improved (28:120). Process analysis is helpful when

1. A complete work process is not readily observable.
2. Several interacting technical systems are involved.
3. There is a high disruption in the work process.
4. Cause and effect relationships are not clearly understood (28:121).

Managers must be appraised of process problems hindering employees' efforts to produce total quality products and services. Inefficient processes stand in the way of pride of work and teamwork, de-emphasizing a "team members" attitude within the organization (21:44-48). Participative decision making is practiced through the use of Process Action Teams (PATs). To determine solutions to "barriers to quality", the roles and functions of PATs must be understood.

A PAT is composed of personnel designated by management who meet periodically to discuss, analyze, and resolve work-related problems. PATs pay specific attention to improving work processes in the interest of eliminating barriers to achieving total quality in production and services. If necessary, PATs may cross divisional lines and organizational levels.

PATs employ the scientific approach to improving the work processes. General tools of the scientific approach include logic, reason, analytical problem solving, and data research and analysis. To aid the PATs, facilitators act as "coaches", directing the scientific method approach to determine effective solutions to assigned problems. Top management should monitor Process Action Teams to demonstrate support.

Service organizations which desire to increase quality and productivity must focus on automating routine functions, consolidating all possible functions, and implementing suggestion programs and quality circles (6:41). The concepts of individual job enrichment and the implementation of work measurement and programs designed to simplify work processes are critical to increasing quality and productivity (6:41). These efforts may be categorized into one of three areas:

1. Effective management of human resources.

2. Automation of routine/ high-volume processes.

3. Redesign of work flows and job duties (6:41).

Job Characteristics and Worker Motivation. Job characteristics theory provides a conceptual framework to evaluate the design of a worker's job to include the process control approach to quality control (17:21). This theory is based upon three psychological states which contribute to worker motivation. These states are feelings of meaningfulness, responsibility, and knowledge of results. The theoretical relationships are schematicized as follows:

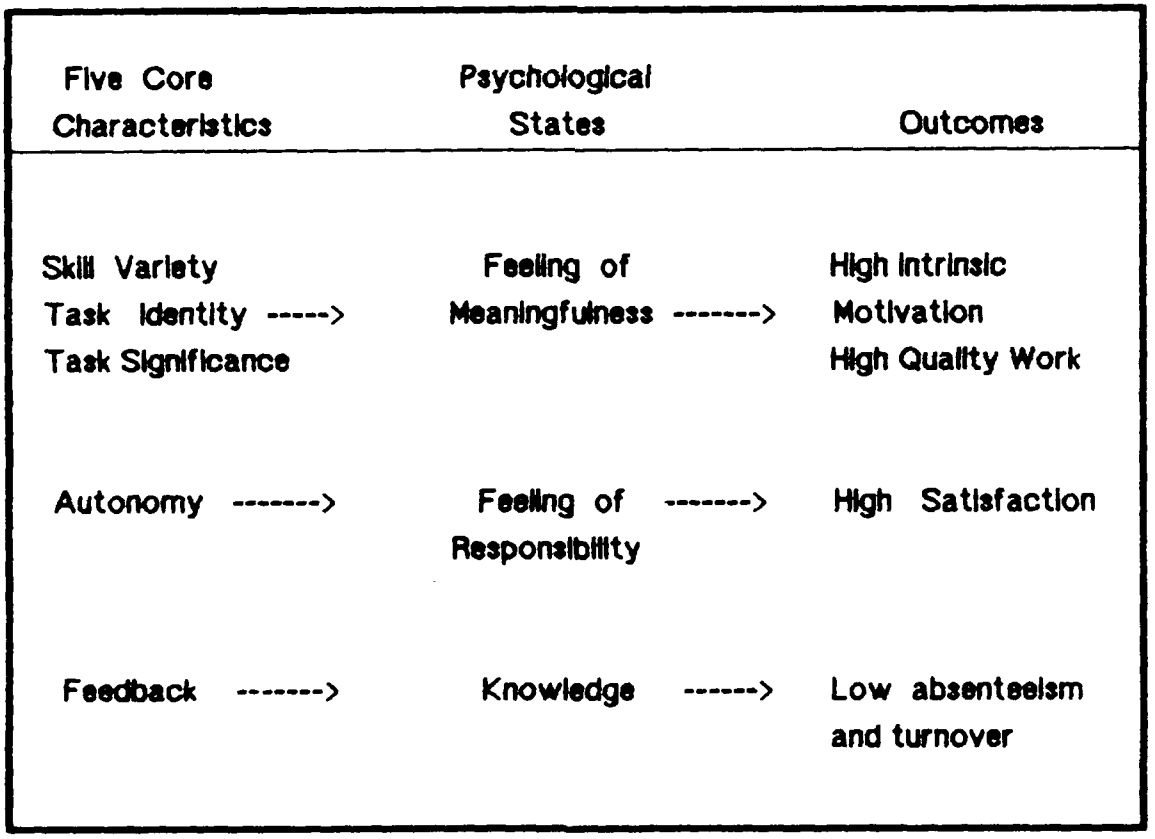

Figure 3. Model of the effect of Job Characteristics (8:121)

Considering each of these characteristics in turn, one may determine the prime motivating factors of the employee's jobs when considering process control.

Job Dimension Considerations. Since TQM efforts require various avenues of effort on the part of the employees, it is important to determine and communicate how employees may directly benefit from their quality improvement efforts (31:20). One such benefit would be to determine the reduction of impediments that hinder employees from doing their best work. By reducing or eliminating process barriers to achieving total quality, the worker's tasks become easier to perform.

Another potential benefit to workers is the enhancement of job content, similar to that observed in job redesign. These and other potenial benefits of the TQM program must be understood by the employees when the TQM program is begun.

Quality Indicators. By definition, a quality indicator can be a single measure or combination of selected measures which provides simplified information concerning the state of affairs a system is in or will be in over time. Quality indicators may be categorized into three types: result indicators, work indicators, and environmental indicators (30:36). Deciding which type of indicator to use is made after considering the activities

and functions that display and explain performance, e.g. statistical information, cost analysis studies, etc. (30:37).

The following quotation points out benefits of the use of indicators. Using quality indicators aids managers in organizing, planning, and decision making in their quality programs (30:35).

> Planning with the help of indicators can bring better results... a useful by-product of using this technique is that it will improve communication among various components within the program, an element which is generally lacking in many situations. Since the establishment of indicators requires information from all sources of the quality implementations, there would be an increased participation and better communication. This collective participation will provide better feedback, improve upon the quality of the indicators, and bring about a collective satisfaction thereby resulting in a superior product. (30:40)

Quality indicators are useless unless proven valid and reliable. In order for an indicator to be deemed valid, a change in the phenomenon which the indicator represents must be reflected by a corresponding change in the indicator. Correspondingly, in order for an indicator to be reliable, it should reflect consistent results for the same phenomenon when measured more than once. When using quality indicators, managers must take into account any possible seasonal, geographic, or cultural biases which might affect the performance of the indicator (30:37-38).

The figure shown on the following page is a checklist of variables to determine the amount of progress an organization has made in implementing TQM:

Variables	Department Involvement		
	Extensive	Some	Little
TQM implementation			
Top management commitment to quality shown in all management actions			
Customer orientation attitudes			
Teamwork at all levels seen as key to improving service delivery			
Quality management training provided at all levels			
Accountability for quality and productivity tied to performance evaluation			
Recognition and incentive programs used creatively			
Sets measures and standards for quality service delivery			
Efforts underway to eliminate barriers to productivity and quality			
Constant stimulation to improve quality and productivity			

Figure 4. Variables to measure in determining progress of implementation of Total Quality Management practices. (5:40)

Statistical Process Control. One key element in the concept of continuous quality improvement of processes is Statistical Process Control (SPC). SPC is based on the premise that all processes exhibit variation. "SPC is an analytical technique for evaluating the processes and taking action based on stabilizing the process within desired limits" (13:23).

SPC is most effectively used by an operator of a process, assisting the operator's decision of whether or not to adjust, leave alone, or shut down and take corrective action before defects occur (13:23). SPC distinguishes between natural process variation (expected), and the non-desirable, unexpected variations which are Assignable to malfunctions, or indications that the process is no longer in control (13:23).

SPC is a broad term which encompasses many tools. The following is an outline of objectives and methodology for seven of the most basic quality control tools.

1. Plan, Do, Check, and Act. The PDCA cycle is a problem solving tool by trial and error, consisting of the following iterations:
    a. Plan the work.
    b. Execute.
    c. Check results.
    d. Take action if there is a deviation between actual and desired results.
    e. Repeat the above cycle until deviation is reduced to zero.

2. Data Collection and Analysis.

   a. Define specific reasons for the data collection.

   b. Decide on measurement criteria.

   c. Assure accuracy of measuring equipment.

   d. Randomize and stratify data collection (time, material, operator, type and location of defects).

   e. Analyze data using several SPC tools.

3. Graphs and Charts. Use bar charts, line charts, and pie charts to organize, summarize, and display data and statistics. Their main objective is to display Trends, reduce data, or communicate and explain data.

4. Check Sheets/Tally Sheets/Histograms/Frequency Distribution Diagrams. These tools are used to simplify data gathering and arrange data for statistical interpretation and analysis. Histograms and frequency distributions provide a graphical portrayal of variability.

5. Pareto Distributions. Juran converted Pareto's law into a usable strategy to separate the few important causes from the trivial many and prioritize them.

6. Cause and Effect Diagram. Lists all possible causes that produce defects in a process. This diagram is less than optimal since it allows only one cause to be varied at a time, overlooking interaction effects.

7. Control Charts. Main purpose is to maintain a process under control, once its inherent variation has been established and minimized. Control charts do not solve problems, but confirm that problems do exist (14:23-28).

Just In Time Inventory Control

Just In Time (JIT) is a philosophy which stresses the minimization of both inventory and lot size (34:19). The ultimate goal of JIT is a production quantity of one.

The objectives of JIT inventory control are to reduce work-in-process (WIP) inventory, queue sizes, lot sizes, and the non-production (front-end time) part of total lead time (34:19).

Many claim JIT inventory control is a strategic quality program in its own right.

> The biggest benefit of JIT is the effect on lead time and quality. As work-in-process and inventory levels are reduced, quality problems are identified and corrected earlier, which results in lasting improvement. The responsibility for quality is placed on each person as he or she performs a function at the lowest level. (34:19)

Moreover, by having the operators check their own work, real time defect data can be obtained to aid in determining the true cause of a problem. "This will allow for the removal of in-line inspect operations, thereby reducing cycle times and improving yields" (34:23).

It is true, therefore, that the proper use of JIT can improve quality. However, successful operation as a JIT producer requires that the company first utilize TQM practices.

> An all too common scenario is the one in which the decision to move to JIT is made before quality problems are resolved. This results in failure, frustration, and the JIT errors. (38:69)

JIT inventory control pays closer attention to the customer/supplier relationship, placing quality responsibilities in the hands of the supplier.

> We're becoming true partners with all our suppliers and all parties are the better for it. They provide rapid response to any changes we require. (26:52)

Westland advocates that the first step toward receiving consistently good products from a supplier is to evaluate its quality capability. "A potential supplier whose price and delivery are exceptional but whose quality capability is poor should be disqualified" (38:70).

In JIT, therefore, high quality begins with the purchased raw materials. Many companies use a supplier certification program, identifying suppliers that demonstrate proven abilities to meet specifications with rapid response. Gillette requires suppliers to provide internal inspection results that provide evidence of the supplier's quality control practices (26:53). The responsibilities of a certified supplier include:

1. Control production processes during manufacturing to prevent nonconformities.
2. Control products produced by these processes and measure conformance against acceptance criteria that will ensure the products shipped will meet specifications.
3. Provide suitable quantitative and/or qualitative inspection data with each lot to provide evidence of lot acceptability.
4. Maintain integrity of the production lot and ensure traceability of inspection data to the specific lot.
5. Develop internal and external feedback systems to provide prompt and effective corrective action when required (26:53).

Many question the potential of JIT in governmental organizations. However, in June, 1989, General Hansen sent letters to 3,864 companies telling them that contractors who consistently deliver the best value will be those who get future contracts (2:1).

> We intend to identify our top performers in terms of product quality, on-time delivery performance, price reasonableness history, and customer service. Such top performers will have a clear competitive advantage over poor performers. (2:1)

It is important to understand that JIT is not a stand-alone program.

> It is not a panacea for attaining a world-class quality position in the marketplace. JIT is a tool that helps ensure that quality products are made on time and cost-effectively. Total Quality Management is the catalyst that enables JIT to be successful. (38:70)

Federal Government Efforts In TQM

The Office of Management and Budget (OMB) is tasked with directing and managing the Federal Government's TQM effort. Chapter 1 of this research project details TQM history in the federal goverment. The following section relates up-to-date efforts and experiences of government agencies with TQM.

OMB defines Federal objectives of the TQM program:

> The federal program is designed to promote the timely delivery of high-quality, error-free, cost-effective products and services to the American public, using delivery systems that respond to customer needs and make the most effective use of tax dollars (5:38).

TQM benefits Federal Government in the following ways.

1. Builds and sustains a culture commited to continuous improvement.

2. Focuses on satisfying Service needs and expectations.

3. Requires dedication, commitment, and participation from top DOD leadership.

4. Involves every individual in improving his own work processes.

5. Creates teamwork and constructive working relationships.

6. Recognizes people as the most important resource (39:2).

OMB reports that a few governmental agencies have made great gains in TQM; however, most are just beginning in implementing TQM (5:38). Some of the successes thus far are in the Forest Service, the Internal Revenue Service (IRS), and the Naval Air Logistics Command (NALC).

Statistics from the Forest Service's implementation of TQM show that unit costs have been reduced by 15% (5:39). The IRS reports that error rates for tax return processing are down by more than 70% in just one year (5:39). NALC predicts that its depots will save over $1 billion by 1991 through the reduction of quality failures (5:40).

Summary

Total Quality Management is a management philosophy stressing leadership, training, and motivation to continuously improve all work processes in an all-out effort to produce the highest quality products and services. TQM

utilizes specifically designed strategies and tactics to bring about organizational changes to increase the quality and productivity of goods and services. This new, higher state of being is termed the "quality transformation" (8:138).

TQM especially emphasizes the importance of satisfying the customer, top management commitment, and involving employees in teamwork problem-solving. Top management encourages and motivates employees to work towards making the quality transformation. Moreover, top management must plan and coordinate the TQM program, as well as strive to change the organizational culture and norms into one which emphasizes the importance of quality over quantity. A very popular vehicle used to improve the work processes and alter norms and organizational culture into stressing quality is the Process Action Teams. Through PATs, participative decision making takes place at the lowest levels, essential to becoming a Total Quality organization. The importance of worker motivation can not be overstated in a TQM effort. If the workers are not highly motivated to improve, efforts to improve quality will have little effect.

Total Quality Management is greatly needed and used today by American industry in an attempt to compete with overseas businesses in quality of goods. Lately, service industries have gotten on board with the TQM program to increase quality of their services (17:5). The federal

government has recognized similar requirements for TQM. In response to the presidential call for improved organizational performance, the DOD has officially committed itself to Total Quality Managment implementation in all agencies.

IV. Case Study

Overview

Chapter 4 documents how TQM was implemented. The overall TQM program in AFLC, "QP4", provides background and guidance to all AFLC organizations implementing the quality improvement efforts. In accordance with QP4, TQM was implemented in the CE squadron in three phases: Inception, Strategic Planning, and Action.

QP4

AFLC's TQM program strives to achieve quality through "QP4". QP4 stands for achieving quality through people, process, performance, and product (4:4). Achieving quality through people refers to top management commitment and employee awareness/participation. Managers must

1. Commit to the new Total Quality program.
2. Promote teamwork, pride, loyalty, and patriotism.
3. Respect the individual's hard work, intelligence, and commitment.
4. Encourage risk-- challenge existing systems without fear.
5. Seek tough challenges-- apply creativity, innovation, and imagination. (27:4)

Employees are tasked to

1. Learn the quality principles.
2. Challenge all processes.

3. Recommend process improvements.

4. Participate in PATs and Quality Circles.

5. Accept responsibility for their actions (4:5).

The second goal of QP4 is to achieve quality through continuous process improvement.

> Process improvement must be a team effort, and is every employee's responsibility. Process Action Teams consist of people involved with their processes, communicating with each other, and analyzing the processes from beginning to end. The primary idea is to understand and control the processes by monitoring/charting pulse points, reducing variations, implementing improvements, and monitoring the processes. (4:5)

The third goal of QP4 is to achieve quality through performance, namely satisy the customer. Emphasis must be change from customer acceptence of goods and services to customer satisfaction of the goods and services. In fact, customer perceptions of the goods and services provided by an organization are the most important evaluation of performance.

> The organization must find the customers, know their requirements, seek customer feedback, improve process performance, and deliver performance as best as possible. (4:7)

Finally, the last goal of QP4 is to achieve quality through product quality and supplier relationships.

> The overall quality of the product depends upon the quality of the goods and services entering each process. Therefore, opportunities must be created for innovative approaches in aquisition of material that will encourage suppliers, both internal and external, to reduce the variability and improve the quality of the items being provided. (4:7)

Methods to improve products and services must concentrate on continuous improvement of reliability and maintainability, variation reduction, timeliness, and other quality control related characteristics. Under AFLC's and the wing's QP4 program, each squadron must implement TQM. The following discusses the phases which TQM was implemented in the Civil Engineering squadron.

Inception: Indoctrination, Selling, and Training

The first phase of the WPAFB CE Total Quality Management implementation was the Indoctrination, Selling, and Training phase. This Inception phase was of utmost importance, due to the following three reasons. First, efforts were made by the 2750th Air Base Wing and the CE Industrial Engineering branch to indoctrinate top management and other key squadron personnel to the TQM program. The objective was to get the TQM program started on the right foot and to properly set the tone for a successful quality improvement program.

The second reason that this first phase of the TQM implementation was so important is that top management underwent initial training in the Total Quality Management philosophies and methods of quality improvement. Moreover, top management's full support and commitment to the TQM program was solicited and attained. In any organization, without top management's full and active support for the

TQM program, the push for quality improvement will be doomed to fail (4:2).

Indoctrination. Several weeks were allotted to introduce key squadron personnel to the TQM program. First, a Quality Program Workshop was held. The first words used to introduce the key members to the Quality Program were as follow:

> Today, you are going to take a first step in the new movement toward improving quality in AFLC and in the DOD. We are going to be discussing your role as supervisors in the quality revolution. You may now be thinking that this is just another program. You have seen programs come and go... They were relatively short lived compared to the quality program we are quickly becoming involved in. Let me assure you, that this one can benefit all of us as workers and as supervisors, and that it is here to stay.
>
> General Hansen, the AFLC Commander, can be credited with being far sighted and affording us the opportunity to challenge the quality of the product or service we are providing to the Wright-Patterson community. He has asked us to take a hard look at how we are running the company, how we are doing business.
>
> This opportunity started in Oct 1987, when General Hansen embarked on implementing QP4 to instill an attitude of quality awareness within AFLC. As a result, AFLC has become the Air Force and possibly the DOD leader in the Quality Revolution. The momentum continues to build rapidly. We are starting to play a major role in this quality movement. General Hansen wants us to share our unlimited skills and experience in making the Air Force, and AFLC in particular, more efficient, productive, and cost conscious (22).

This speech is documented along with the rest of the Quality Program Workshop in the WPAFB CE Wang database.

Following this introductory speech, videotapes produced by AFLC HQ featuring General Hansen were shown, outlining goals and objectives of the AFLC program. Secondly, a "trailer videotape" to the General Hansen videotape featuring the wing commander was shown. The Wing Commander's videotape commented on the Wing's role in the quality movement, demonstrating Wing top management support.

The rest of the quality program workshop outlined how the Wing program interfaced with the Squadron program, and what the Squadron program entailed. Quality circles and Process Action Teams were described, as well as the basic philosophy of the TQM program and what it was supposed to achieve.

During a special four-hour indoctrination meeting, AFLC quality program personnel were invited to brief the key Civil Engineering personnel on specifics of TQM. Topics covered included TQM objectives and goals, Process Action Teams, tools for group problem solving, and review of quality theories perpetuated by "quality gurus" such as Deming and Taguchi.

Education and Training. Quality training for the CE squadron managers/leaders was conducted by AFLC using a concept called the "Pyramiad Approach". Basically, this requires education and training to be conducted on three levels, one level at a time. The first level was senior

management-- the Base Civil Engineer and his deputy and all Branch Chiefs. The second level was middle management-- the Section Chiefs. The third level referred to line employees.

First, senior management was educated and trained. As already pointed out, senior management education and training was of utmost importance, because without full commitment from senior management, the quality program would have been worthless. General Hansen writes:

> The first category is senior management. It is our job to create a positive environment, free of fear, for our people to aggressively pursue innovative approaches to institutionalizing quality across the command. (1:1)

Senior management's education and training was focused on "quality awareness training" (1:2). Quality awareness for senior leadership stresses top management committment and involvement for the TQM program, strategic planning, and support for middle management and the line work force.

Quality awareness training needs to be appropriate for senior executives and conducted quarterly as a minimum to maintain top management's expertise in the TQM program, and apprise top management of the latest TQM training. Heavy emphasis was placed on successful case studies, seminars led by invited successful industry quality practitioners, academic leaders and high ranking AF/DOD and Government officials.

Strategic Planning

One of the Squadron top management's duties was to strategically plan how the Squadron will improve its quality and productivity following the TQM method, under supervision of the Wing Quality Council. The following information on the Squadron Quality Committee relates how the structured organization of top management planned quality improvement efforts for the Squadron through a formally organized committee.

Squadron Quality Committee. Following Squadron top management education and training, the requirement existed for the establishment of a formal, structured organization devoted to the quality improvement efforts. Therefore, the "Squadron Quality Committee" was formed. A primary objective of the Squadron Quality Committee was to involve top management in the leadership, direction, and management of the quality improvement program. Therefore, a main duty of the Squadron Quality Committee was to provide guidance and demonstrate top management support for all process improvement efforts.

For the first four months, the Squadron Quality Committee existed and operated without a primary charter. Duties of the Committee were informally understood and practiced for the most part. Finally, after the initial 4 month period, it became clear that a formal charter was required, and was thus written. The CE Squadron

Commander provided the Squadron Quality Philosophy. The main thrust was to improve the Squadron's "image" toward providing quality services to all base customers, housing residents, Headquarters, and Majcom.

> While this may appear "self-centered," we must in appearance be professional, capable, and honest if we are to be in fact effective servants of the taxpayers. (36:1)

The Squadron Quality Committee Charter nominated the Deputy Base Civil Engineer (BCE) with directing the overall Squadron TQM program, and chairing the Squadron Quality Committee. The members of the Committee included all branch heads and key section chiefs.

The Quality Committee Charter tasked the Quality Committee with numerous responsibilities. First, the Squadron Quality Committee dictated primary objectives of the quality improvement efforts. The official primary objective of the WPAFB Civil Engineering TQM program was publicized as follows.

> ... to achieve the highest level of efficiency output from available resources by improving the processes, services, support, and effectiveness of the organization.

Supporting quality goals and objectives were specified.

1. Assume the most economical and effective use of the manpower, equipment, and facilities required for accomplishment of the Squadron mission.

2. Involve all branches in providing the best possible support through accurate, timely, and complete management information, support, and services on a continuous basis.

3. Create and maintain a work environment within the Squadron conducive to excellance, encourages quality, and enhances productivity.

4. Examine external as well as internal use of resources in accomplishing the Squadron workload. (36:4)

The Squadron Quality Committee Charter charged all functional branches within the Squadron to:

1. Achieve the highest levels of efficiency from available resources by improving the processes, services, support, and effectiveness of each branch.

2. Encourage every employee to be aware of and contribute to quality improvements.

3. Aid the Squadron and, in turn, the Wing, by reducing the cost of providing the necessary goods and services and increasing overall capability.

4. Develop and maintain methods to measure efficiency and indicate trends.

5. Identify key processes that can be candidates for improvements.

6. Participate in the PATs and Quality Circles.

7. Communicate with functional counterparts for feedback on TQM actions. (36:6)

The Squadron Quality Committee determined which problem areas and key processes required most immediate attention and were candidates for improvement. Next, the Committee itself decided if and when a PAT should be established to develop solution(s) or process improvements for the problems. Moreover, the formation of Quality Circles to identify and solve problems unique to a shop was encouraged. It was up to the Committee, since

the Committee was composed of top squadron management, to allow the team members to meet for the specified time periods (typically one hour per week), provided the team continued to be productively engaged and was operating in compliance with the PAT guidelines.

An inherent responsibility of members of the Squadron Quality Committee was to occasionally attend PAT meetings. When Squadron Quality Committee members attended PAT meetings, PAT members reported that they were definitely impressed by top management's interest in the individual PAT. Moreover, Quality Committee members became familiar with exactly how the PATs were functioning at the base level, giving them perspective on how their employees were brainstorming problems and solutions.

Another responsibility of the Squadron Quality Committee was to designate an adequate and appropriate meeting area exclusively for quality improvement planning, and equip it appropriately for this function. Essential working materials and supplies must be kept on hand in sufficient quantities at all times. The Squadron designated a large conference room specifically for the Process Action Team and Quality Circle meetings.

When a PAT finished with its taskings and had determined solutions and/or process improvement suggestions, the Squadron Quality Committee was briefed. It then was the responsibility of the Committee to either

1. order responsive actions to implement the PAT solutions;

2. make suggestions for PAT revisions and further work;

3. make requests for additional information or research;

4. notify the PAT of reasons for delayed response;

5. reject the PAT proposals due to stated reasons.

While top management was planning the TQM process in the Squadron Quality Committee, key middle management personnel underwent training and education in the quality efforts. The educating and training of middle management focused on "quality education training" (1:2). General Hansen addressed the importance of middle management training.

> The second category is middle management. This is the group of people who represent the biggest challenge in making quality a way of life in AFLC. Repeatedly, industry experts as well as our own people, warn us that this key group of supervisors is the key to success, yet are the last to be armed with the support and tools to make the program grow. Middle management must translate policy and direction into meaningful action by the work force. (1:1)

Quality education and training for middle managers focused on the critical need for middle management/ supervisors to be able to translate policies and direction, flowing from senior management, into meaningful direction to the work force. Examples of educational targets for PAT tool building and application include flowing and analyzing processes, sorting value-added from non-value added work, and cross functional cooperation.

Line employees also require training in quality improvement tools, techniques, and methods. Line employee training focused on "quality technical training" (1:2). Quality technical training stresses "just in time" (JIT) concepts for the general work force. Concentrated technical training in Statistical Process Control (SPC) and other technical methods was conducted after PATs were formed (See Action phase for the line employee training).

Action

In a speech regarding the AFLC Quality Program, General Hansen stressed the importance of Process Action Teams in identifying and solving inherent quality problems.

> The Process Action Team is the tool to identify a quality process deficiency: appoint a team leader, then have the right people from the various functional areas participate on that team. The teams will make recommendations to improve the processes which they know best-- and I've directed these recommendations be implemented. (22)

The first duty of the Action phase was to actually gather the individuals together who would make up the PATs (referred to as PAT members) and Quality Circles and conduct Process Action Team orientation. This orientation training served to indoctrinate PAT and Quality Circle members in how PATs and Quality Circles function and the problem solving processes. During the Process Action Team's initial meeting, each team member was provided an information kit to familiarize the member with the Quality Program and

the member's role in the PAT. The individual kits included copies of the following documents:

1. A letter identifying the key processes approved for inclusion in the Civil Engineering Squadron Quality program.
2. The Quality Formula Flyer (QP4) showing the Industrial Engineering Branch as the Squadron point- of -contact for the QP4 program.
3. General Hansen's signature article from TIG brief 6, Nov.-Dec., 1988, entitled "Quality Development in Logisitics Command".
4. Definition of a Process Action Team.
5. Work Flow Diagram relevant to the particular PAT receiving training.
6. Problem Solving Process Summary.
7. The Quality and Productivity Team Process Manual written by Professor Virgil Rehg, AFIT/LSQ.
8. The Problem Solving Model Workbook developed by Dr. Rehg to supplement the aforementioned manual.
9. Process Action Team contract.

This first PAT meeting was dedicated to discussing characteristics of Process Action Teams, the objectives of PATs in terms of the philosophy and intent of the Quality Program, and the information kit items. Moreover, the "PAT contract" was consummated (see next paragraph). Finally, particular attention was paid to the roles of the team leaders, the individual members, the PAT Code of Conduct, and the group as a whole.

PAT Contract. The first order of business in an initial PAT meeting was to consummate the PAT agreement. Each PAT member signed a "contract" specifying certain conditions of the PAT (Appendix D provides an example of a PAT contract). Examples of these conditions include when and how often the PAT shall meet, and various group specifics and activities, such as group norms and goals.

The purpose of the PAT contract was multi-dimensional. First, Industrial Engineering facilitators found the contract essential to establishing the commitment necessary to the "PAT" approach to quality improvement. Second, an initial sense of duty and responsibility to the PATs was developed in the members. It was deemed important that the members realize the need to meet on an agreed upon schedule and be prepared to actively participate in the PAT processes. Moreover, the contract instilled a sense of importance in the individual PAT members.

Team Leaders. Each PAT selected a team leader; however, the teams were allowed to rotate leadership among the PAT members during different meetings. The PAT leaders understood that they must support the team's consensus decisions. It was up to the PAT leader to guide but never dictate or unduly influence teamwork. PAT leaders must remember that it is their duty to ensure that the team operates productively and in harmony. Individual PAT leader responsibilities are summarized in Appendix B.

Recorder. On the first day, each PAT selected one of PAT members to be the recorder. In subsequent meetings, the duties of the recorder shifted among the individual members. The recorders were tasked with recording information regarding all events, problem identifying and solving processes, brainstormed solutions, etc. The recorders also prepared PAT meeting minutes for review during the following meeting. Appendix C provides the form used to record PAT Meeting Minutes.

Individual Members. The Squadron Quality Committee directed the selection of the individual members who would make up the PATs. Each team member was tasked with the inherent individual responsibility of being actively involved in the discussions and problem solving sessions while still functioning as a team member and respecting everyone's right to contribute positively to the discussions. It was also important that each member understand, support, and respect majority rule and group consensus. All members must respect and practice the following PAT Code of Conduct.

Code of Conduct. A list of statements was designed and adopted by majority consensus of the PAT members, to be designated the "PAT Code of Conduct" by which all members agree to abide. Examples of Code of Conduct requirements from the CE PATs are provided as follows.

1. Strive for a win-win situation.
2. Abide by the majority rule.

3. Do not condemn, criticize, or complain about any other working member.

4. Criticize the action, not the persons.

5. No smoking during meetings.

6. One for all and all for one.

7. Be on time and attend all meetings.

8. Think positively.

Team As A Group. While all individual members worked to form the group and follow the rules of conduct, it was found constructive to discuss conduct of the team as a group. The overall purpose of the group was described as to make meaningful and appropriate contributions to improving the organization's productivity, efficiency, quality, and proficiency. Status of progress toward these purposes was periodically reported to the facilitator.

When the PATs were formed, the Squadron Quality Committee dictated certain problems and processes which required solutions. It was the group's duty to adequately investigate these problems which they were tasked with solving. Specifically, PATs must fully analyze and document all relevant data. This may include Cause and Effect diagrams, Pareto Analysis, etc. All members had to participate in these brainstorming sessions to add their specific area of expertise to the work of the PAT.

Finally, PAT results in the form of proposals and recommendations were formally presented to the Squadron

Quality Committee and others involved or affected by the PAT findings. The PAT results were presented by the PATs themselves, or by designated members. Following presentations of the PAT results or findings, the PAT members had to respect the final decisions of management in view of constraints on capital, budgets, manpower allocations, organizational goals, or other demands for resources.

The second PAT meetings were dedicated to familiarizing the members with the tools and techniques they would be applying as a Process Action Team. The facilitators essentially walked PAT members through the Quality and Productivity Team Process Manual, highlighting the application of various tools such as brainstorming, Cause and Effect diagrams, Pareto Analysis, and decision making by consensus. Using the Problem Solving Workbook provided PAT members with realistic hands-on training using problem-solving tools and techniques. Appendix E provides a working summary of these tools and techniques.

In the third and remaining meetings, the facilitators tried to allow the PAT members to essentially "go solo". From this point on, the facilitators from the Industrial Engineering Branch primarily acted as a consultant to the PATs. When PATs strayed far from the tasks at hand, the "PAT consultants" (DEI) steered the discussions back on track to avoid wasting valuable time and to reinforce

learning and problem solving. Whenever PATs desired to apply some of the more sophisticated problem solving techniques, the facilitators stepped in and demonstrated effective and proper uses and applications of the tools or techniques being attempted. Appendix F provides a summary of the specific duties of the facilitator.

When PATs finished their problem solving processes and reached a solution(s) to the problem(s) at hand, the PAT members proudly presented the recommended solutions to managment and the Squadron Quality Committee. The presentations were made with graphs, charts, and any other information relevant to the processes which had been assigned for PAT review and discussion by the Quality Committee. The purpose of the management presentations were to make recommendations and proposals for management consideration. Whenever applicable, an economic analysis to prove which was the better alternative from a long-run perspective was included.

Quality Circles. Quality Circles were also utilized, providing employees opportunities to participate in improving processes. Quality Circles differ from PATs in that the QC members were volunteers, working on common problems. PAT members were assigned by the Squadron Quality Council to work on key processes as assigned by the Quality Council. Moreover, PAT members crossed normal

divisional borders, while QC personnel typically originated within a certain section.

Chapter Summary

The main acronym describing the TQM program in AFLC is QP4. QP4 is the main TQM program guiding all other TQM implementations throughout AFLC organizations; since the WPAFB CE Squadron serves an AFLC base, the CE Squadron falls under the QP4 umbrella. However, the Squadron was free to implement TQM without any strict guidelines or restrictions from QP4.

TQM in the CE Squadron was implemented in three main phases: Inception, Strategic Planning, and Action. Overall, the Inception phase consisted of top and middle management education and training, which was very thorough and consistent. The Strategic Planning phase was the "weak link" of the implementation, mostly due to lack of total top management commitment to the program. Actually, the Industrial Engineers performed most of the Strategic Planning with mere "guidance" from Squadron top management.

The Action phase was the most busiest, and probably the most successful. During the Action phase, lower level employees learned and participated in TQM efforts. As documented in the following chapter, great gains were made due to the expertise of both the facilitators and the lower level employees in their fields.

V. Results and Discussion

Chapter Overview

This chapter presents the research findings resulting from the several Process Action Teams, Quality Circles, interviews, and Quality Questionnaire, which was administered to determine a change in quality attitudes of the employees. Results of the Quality Questionnaire inferred statistically significant increases in employee perceptions of organizational quality. Next, results and data from two of the various Process Action Teams and Quality Circles that were held are provided to give insight on accomplishments that were made in a very short time period. Lessons learned provide final comments regarding the TQM implementation, detailing potential pitfalls for future facilitators to be aware of.

Quality Questionnaire Survey

A copy of the Quality Questionnaire is presented in Appendix G; Chapter 2 Methodology discusses applicable validity and reliability of the survey, as well as the statistical t-tests and who originally designed the survey. This section reviews the data of the t-tests from each individual question, including interpretation of the results.

In performing the individual t-tests for each question, the Null Hypothsis was that there was no

difference between the means, or mean employee quality perceptions were not significantly different between the "Control Group" and the "Affected Group". The Alternate Hypothesis stressed significant differences between the means, which claim that the answers from the "Affected" thirty employees resulted in statistically significant different levels of quality perceptions than the control group.

Data Analysis and Results. Appendix I provides a table of the statistical data resulting from each individual question's t-tests, along with p-values and whether or not the Null Hypothesis was rejected. Figure 5 on the following page compares the means of each of the six main categories of quality measurements from the Control and Affected groups. The six main categories of quality measurements used by the Quality Questionnaire survey were as follows.

1. Leadership: Leadership was measured by supervisory communication, participative decision making, commitment to quality, and shared vision.

2. Strategic Quality Planning: Strategic Quality Planning was measured by goal clarity and goal congruence.

3. Human Resource Management: HRM was measured by training adequacy, involvement, empowerment, expectancy, role clarity, and recognition/ feedback.

4. Quality Assurance of Products and Services: Q/A was measured by examining the entire quality system.

5. Quality Results: Quality Results was measured by external and internal measures of quality.

6. Custmer Satisfaction: Customer Satisfaction as seen by the employees was measured by responsiveness and feedback.

Means By Categories

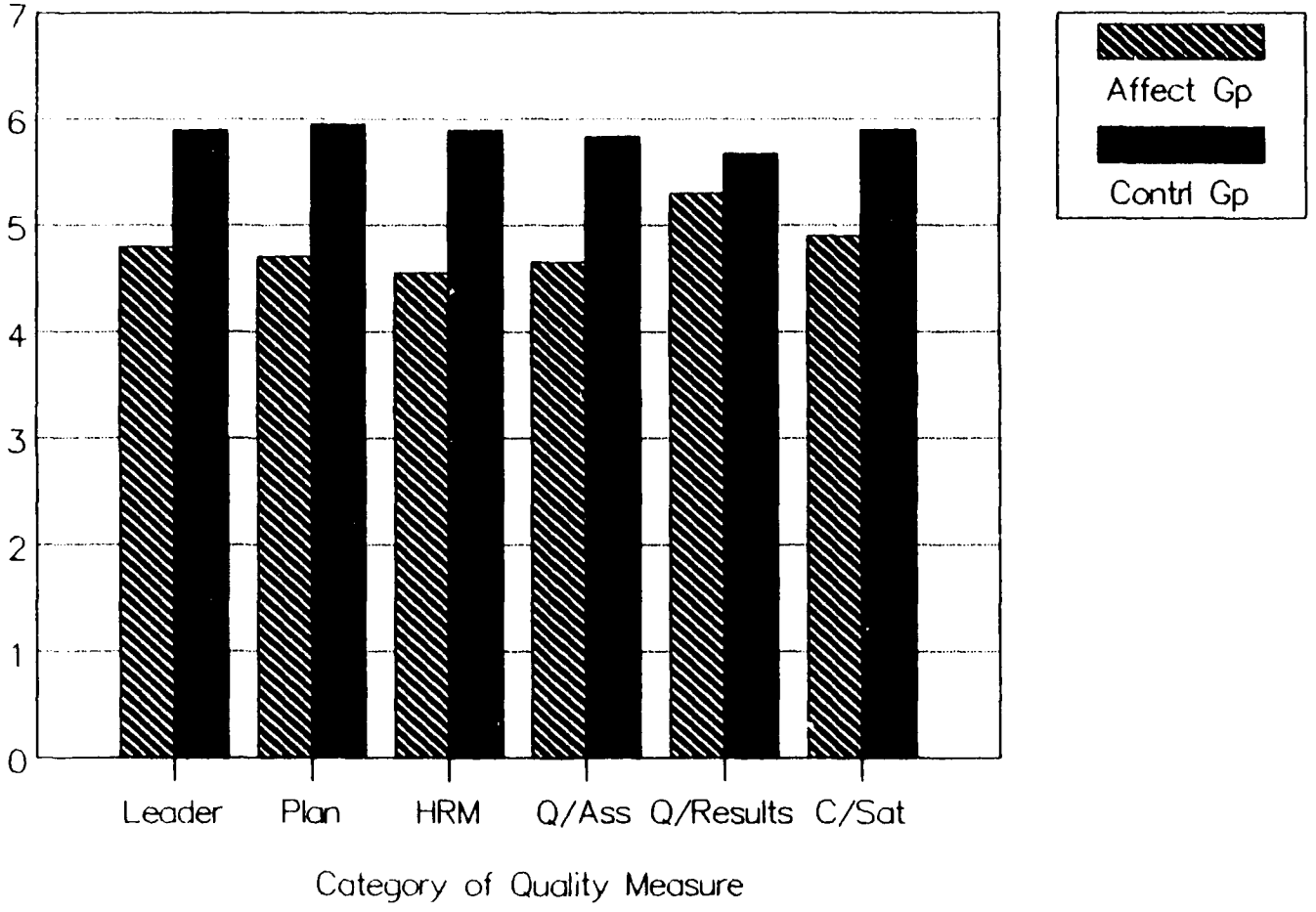

Figure 5. Graph of Means by Categories

Upon examination of the chart on the preceding page or the table in Appendix I, it is clear that all questions except questions 15, 19, 41-45 demonstrated p-values less than the .05 level, rejecting the Null Hypothesis. Therefore, for all questions except for 15, 19, 41-45, the Alternate Hypothesis was inferred to be true with greater than 95 percent confidence.

This research may now claim for all questions except numbers 15, 19, and 41-45, statistically significant improvements in employee perceptions of organizational quality are proven due to just eight months of Total Quality Management. Assuming other confounding factors were not responsible for the demonstrated increases in quality, the TQM implementation resulted in a significant increase in perceived quality in Process Action Team members and others involved in the TQM program.

Questions 41-45 comprised the only full block quality perception measurement that failed to demonstrate a statistically significant increase. Questions 41-45 measured external and internal perceptions of quality results. Examples of these questions include:

-- Your organization is as good as any other similar organization.

-- The results of work in your organization meet your customer standards.

-- In your organization, everyone knows how important it is to do things right.

Interpreting the failure of questions 41-45 to demonstrate statistically significant differences in quality perceptions when all other blocks of quality measurements were successful suggests that employees did perceive all other types of quality improvements throughout the Squadron, but had not yet perceived improvements in the internal and external quality results of the organization. In other words, the Squadron has made a valid start toward improving organizational quality, but still has much more to achieve. Considering that the TQM implementation is really still in its infancy, this "criticism" on the part of the employees is not only valid, but was to be expected. Furthermor the fact that 6 of the 8 questions which did not demonstrate statistically significant improvements in quality perceptions all fell within the same block lends credence to the validity and internal reliability of the survey instrument.

The main conclusion derived from this research is that the TQM implementation was successful in motivating employees to perform at increased quality levels. In the short run at least, employee perceptions of organizational quality were much improved.

PAT Reports

Over the 12-month TQM implementation period, eight PATs and one Quality Circle were formed. Six of the eight PATs

began and completed their assigned taskings. The six PATs which began and finished their assigned objectives covered the following subjects:

TABLE I

Process Action Team Listing, WPAFB CE Squadron, 1989

- Heating Plant Processes
- In-House Work Orders
- Steam Traps
- HVAC Response
- EMCS: Energy Management & Control Systems
- Performance Awards

The following discussion details general PAT results from two of the PATs: the Performance Awards PAT, and the HVAC PAT. The use of tools such as Cause and Effect Diagrams and Pareto Analysis are demonstrated.

Performance Awards PAT. The first PAT to start and finish its assigned tasks was the Performance Awards PAT.

Top management recognized that managers needed some sort of systematic guidelines to follow in annual distributions of performance awards. Since the actual problems with the performance award distribution systems were not clearly defined, the first task of the PAT was to brainstorm problems, or "barriers to quality". The following main problems were determined.

Table II

Performance Award PAT: Brainstormed Deficiencies

- Rotating awards without regard to actual employee performance.
- Selecting award recipient without standards and guidelines
- Selecting award recipient from inflated appraisals which make it unclear who is most deserving.
- Selecting award recipients with limitations of fixed amounts of award monies per organization.
- Union/Equal Employment Opportunity (EEO) pressures on supervisors to award certain individuals.

The problems were next ranked by mutual consent to determine the most serious, and prioritize them. Rotation

of awards without regard to performance was found to be the most disturbing. Pressure on supervisors and lack of standards/guidelines were agreed to be very detrimental.

Goals of the performance award system were brainstormed using the Nominative Group Technique.

Performance Award System Goals

Goal	How To Achieve
-- Get the most out of the available monies.	-- Superior performance will be recognized.
-- Recognize as many individuals as possible.	-- Excellant performance should be recognized
-- Divide up the available monies in the "best" manner possible.	-- Fully successful performance may be recognized.
-- Include all supervisors in determining award winners.	

Figure 6. Goals of the Performance Award PAT

The PAT mutually decided the best method to meet these goals and solve the award system problems was to design, distribute, and utilize a new "performance award checksheet" throughout the organization. A copy of this checksheet is

provided in appendix H. Furthermore, the PAT authored guidance relating types of possible awards with deeds performed.

Following the distribution of the checksheet, a measurement of the PAT's results was desired to determine this first PAT's effectiveness. A performance awards checksheet survey was distributed to all supervisors to determine if the guidelines were helpful and important to the field supervisor. Sixty-two percent of the supervisors reported that the checksheet was helpful, while a full seventy-three percent of the supervisors reported that they would extensively utilize the checksheet. Numerous anecdotal reports from the field further commended the work accomplished by the Performance Awards PAT. Since the Performance Awards PAT was the first to begin and finish its assigned taskings, the success enjoyed by the PAT buoyed the other PATs that were in progress-- support for the TQM implementation was growing rapidly.

HVAC Response PAT. An HVAC PAT was established due to customer complaints that Civil Engineering was inadequately responding to Base HVAC problems. Table 3 provided on the following page relates deficiencies identified by the HVAC Response PAT hampering quality and productivity on the part of HVAC personnel and shops.

In order to prioritize these problems, Pareto Analysis was performed. The following table provides results of

Table III

HVAC Response PAT: Brainstormed Deficiencies

- Problems locating requestor who initiated the call.
- Insufficient information on the Job Order relating the HVAC problem.
- Poor identification of HVAC problem prior to site visit.
- Poor Planning for replacement parts to repair problems.
- Lack of Proper tools and equipment.
- Time lag in distributing calls between shops.
- Lack of standard guidelines for customer service in classifying service calls.
- Poor communication between shops in dealing with service calls.
- Jurisdictional disagreements.
- Lack of proper training and manpower levels.

the Pareto Analysis, where the defect with the highest response percentage is accepted as the most important problem affecting HVAC response.

Table IV

HVAC Response PAT Pareto Analysis

Defect	Percent	Cumulative
9	11.56	11.56
6	10.22	21.78
8	9.78	31.56
4	9.33	40.89
3	9.33	50.22
10	9.33	59.56
12	8.89	68.44
1	7.11	75.56
5	6.22	81.78
All Others	18.22	100.00

The PAT brainstormed solutions to the four categories of deficiencies identified on the Cause and Effect (C/E) diagram. Emphasis was placed on the problems identified most critical by the Pareto Analysis. The figures given on the next two pages are the results. Note that the solutions were arrived at in the four categories identified by the C/E diagram.

HVAC Response PAT Cause/Effect: Procedure

Problems	Solutions
-- Jurisdictional ambiguity	-- Two-way radios, work teams, pagers.
-- Lack of written procedures/guidelines	-- Develop procedures, shop/service call checksheet.
-- Communication problems	-- Pagers, clerk devoted for comm.
-- Reporting Problems	-- Train originators, receivors, building managers.
-- Premature heat/cool shutdown.	-- Delay shutdown IAW weather conditions. Update guidelines.

Figure 7. HVAC Response problems and initial solutions: Procedure

HVAC Response PAT Cause/Effect: Materials

Problems	Solutions
-- Low shop stock	-- Improve stock type and quantity
-- Unreliable parts	-- Credit card purchase authority for shops. Provide Supply w/a list of acceptable parts. Increase funding for parts. Utilize impress funds. Employ a knowledgable shop stock manager.

Figure 8. HVAC Response problems and initial solutions: Materials

HVAC Response PAT Cause/Effect: People

Problems	Solutions
-- Attitude problems.	-- Improve worker communications. Supervisor coordinates between shops. Promote team building spirit.
-- Shop credibility problems	-- Write shop guidelines on responsibilities. Increase intershop communications.
-- Intershop conflicts.	-- Place Controls under Mechanical shop. Clarify functions, Give pos. recognition. Resolve conflicts at DEM level.
-- Lack of goals.	-- Develop clearly- stated goals. Use craftsman input on long-range improvements.

Figure 9. HVAC Response problems and initial solutions: People

HVAC Response PAT Cause/Effect: Equipment

Problems	Solutions
-- Incompatible Systems. Old Systems.	-- Implement HVAC improvement program.
-- Lack of proper tools.	-- Identify requirements, procure them.
-- Poor O&M Data.	-- Revise and check data

Figure 10. HVAC Response problems and initial solutions: Equipment

Specific solutions to the main problems were devised to occur immediately (within 30 days), short-range (within 90 days) and long-range (after 90 days).

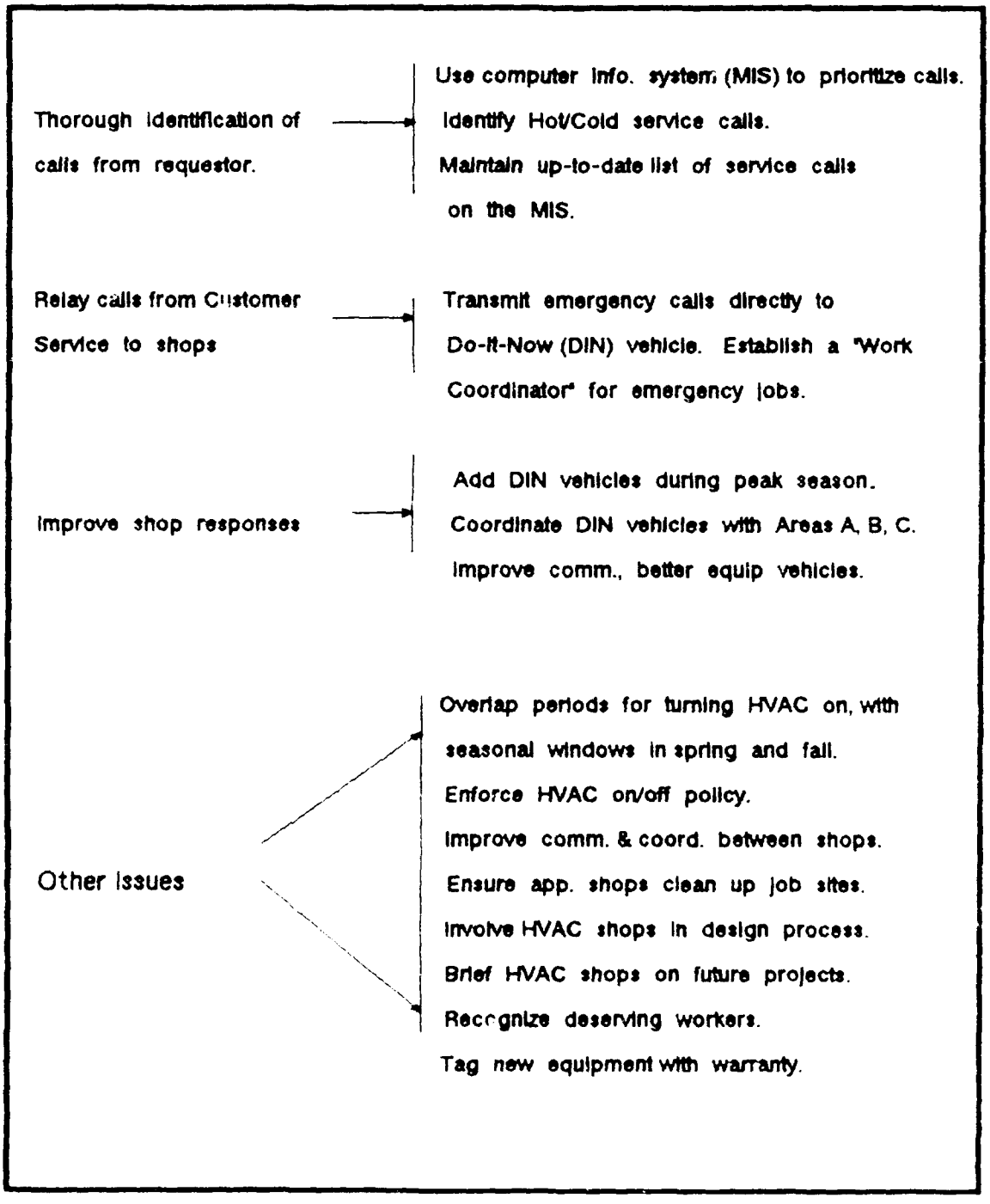

Figure 11. HVAC Response PAT implementation strategies.

Due to the large number of brainstormed solutions, only the short-range solutions were included in Figure 11.

Figure 12 briefly summarizes two other PATs that were held and finished at the time of this writing, the Heat Plant PAT and the Steam Trap PAT.

Objective	Result
Steam Trap PAT	
-- Develop & maintain a cost effective steam trap program to minimize steam heat energy loss.	-- Establish a full time crew of 4 for each area. -- Use Z-248 computer to track data. -- Use written operating procedures -- Increase tools and spares
Heat Plant PAT	
-- Improve operating efficiency of both plants.	-- Program immediate projects to preclude failure. -- Survey to determine long-term design projects. -- Contract to provide b/up power. -- Determine boiler improvements with power pro. personnel. -- Improve coal sampling & training. -- Review coal suppliers qualifications. -- Increase maintenance schedules. -- Improve coal specifications.

Figure 12. Steam Trap and Heat Plant PAT Objectives and Results.

At the time of this writing, six other PATs were in progress, with many others planned.

Of the other PATs planned, several topics are being explored outside of the Operations arena-- due to the Operations and Maintenance branch's demonstrated successes, other branches in CE are establishing Process Action Teams. For example, the CE Design Banch (DEEE) has expressed interest in improving such processes as design reviews with the customer-- improving customer satisfaction would be the ultimate goal here.

Lessons Learned

Many observations and lessons were learned throughout the TQM implementation. A working summary follows.

1. The TQM program constantly evolves, and is never-ending. The more we accomplished, the more we found could be done, and still can be accomplished.

2. The TQM program surely requires requires full commitment, first from top-management, then from middle management on down. Any "weak link" in the "chain of commitment" will profoundly weaken the entire program.

3. Many solutions that were arrived at that seemed to overlap. For example, almost all PATs determined the need to write procedures and increase training. These seem to be a sure requirement to improve quality and productivity.

4. All individuals need to participate, both in the PATs, and in all quality improvement efforts.

5. Top management must deliver an ultimate vision, and all employees should strive to accomplish the vision.

6. Including employees in improving processes which they work by surely increases morale. PAT personnel reported that above all else, they felt an increased sense of importance, that management cared about the work they were performing.

VI. Conclusions and Recommendations

Conclusions

Total Quality Management is, indeed, a management strategy which demonstrates the potential to improve quality and productivity in an organization. However, the implementation process is very lengthy, requiring top management and all other employees' full commitment.

Most TQM models in the literature stressed stages of TQM involvement, ranging from general awareness to full practice and impelementation. It would have been easy to stop at general awareness of the desire to improve organizational productivity and quality without going through the hard tasks of working for those improvements. However, the CE squadron is to be commended for their diligent efforts in TQM and continuous process improvement. Indeed, awareness was achieved, although top managment's vision was lacking. A support structure was created, with strong educators and PAT facilitators. However, the Squadron Quality Council was especially lacking in providing direction to the process improvement efforts. Despite top management's lack of full support, accomplishments were recognized and publicized.

Many general benefits of the PATs and QCs were observed, and are included in the following table.

Table V

Observed Process Action Team Benefits

- Provided opportunities for individuals to participate.
- Tapped the creative intelligence of numerous "experts" in the field.
- Developed the individuals, increasing knowledge and morale.
- Fostered employee "ownership" of the processes.
- Increased "attention to quality".
- Increased "quality attitudes", improving organizational quality.

Of the above benefits, the most important was "fostering employee ownership of the processes. Since the workers themselves have a hand in improving and defining the processes which they use in their every day-to-day efforts, they become proud of those processes, and strive to make them work to the highest degree of quality.

It was clearly observed that the creative capacity of the employees was an immeasurable resource; harnessing

this human energy and specific expertise could pay handsome rewards greatly exceeding the time and efforts expended.

TQM literature specifies that employees are frustrated when they are not able to produce quality products and services due to defective processes. It was clear that squadron personnel involved in the quality program experienced increased satisfaction in the perception that their work processes were being improved, and that management was "finally listening to the employees".

An increased awareness of quality was definitely reported, as evidence by the Quality Questionnaire. Through a cross-feed of information which occurred in the team problem-solving meetings, members became aware of their roles in the Squadron. This, in turn, led to increased organizational enthusiasm to co-workers, cascading the "quality spirit".

Suggestions

More is needed. First, other sections and branches of the CE Squadron need to begin TQM implementation, and have expressed interest after seeing firsthand the gains achieved in Operations. As for the TQM implementation in the Operations branch, the literature expresses that a TQM program is always evolving. The following table outlines

suggestions for the immediate future of the TQM implementation researched in this project.

Table VI

Suggestions For Further TQM Implementation

- Devise better measurement systems.
- Determine, measure, publicize amounts of reduced wastes.
- Work with other Base organizations to improve interorganizational processes.
- Employ JIT inventory control tactics.
- Increase top management involvement.
- Institute far-reaching recognition programs.

More of an effort must be made to involve the customer in every aspect of the job-- set true customer requirements. "Mere conformance to requirements only leads to user satisfaction when there is alignment between user expectations and user requirements" (13:7).

If any criticism is to be levied in this thesis, it would have to be on the part of top management of the Squadron. One employee related in confidence, "If it were not for General Hansen continually demonstrating top interest and involvement, the push from top management in this Squadron would seem non-existent". Indeed, the Industrial Engineering facilitators carried out a magnificent job both as acting as facilitators for the PATs, and covering up for lack of Squadron top management involvement.

Recommendations for Further Research

The researcher has observed numerous benefits from the TQM implementation in the CE Operations and Maintenance Branch. However, much remains to be accomplished. The TQM program should be extended to to improve all processes within the CE branches and sections, not just O&M. In fact, there are many personnel and processes within the O&M branch itself still unaffected by the TQM program.

Hawthorne Effect. The Quality Questionnaire quantified significant quality perception improvements on the part of employees who were involved with the TQM program. However, some may argue that a "Hawthorne Effect" is to blame. This argument would contend that the TQM program has caused quality to improve in the short run merely due to increased managerial attention to the suggestions of lower-level

employees. Further, in the long run, this effect will die out, and the organization will return to the original quality levels that it exhibited prior to the TQM implementation. To answer this very serious assertion, it is contended that TQM requires constantly evolving improvements, since the TQM implementation is really never complete. New gains in participative management and process improvements over time should negate the Hawthorne argument. However, to prove this, a study of the TQM program over time would be in order.

Another recommendation for further research is to conduct a similar study of TQM implementation and its effects on another organization completely unrelated to Civil Engineering. It is DOD's assertion that TQM will be implemented in all organizations. Therefore, studies should be conducted to determine TQM effects on organizational quality and productivity on many different organizations throughout the DOD.

Appendix A: Functional Duties of CE O&M Sections and Units

Operations Branch.

1. Directs the activities of the Chief of Logistics and Requirements, Operations Superintendents and Chief of Systems Management

2. Manages all activities and approves plans to improve the physical arrangement and layout of shops, plants, and service areas of the Operations activity.

3. Helps Operations Superintendents resolve problems concerning work progress and supply support.

4. Directs and controls the identification, planning planning and accomplishment of all work selected for the Operations and Services and the Recurring Work programs.

5. Directs and controls budget inputs to the financial manager for in-service work and equipment repair and replacement.

6. Reviews and evaluates designs (from a facility O&M standpoint) for all work to be done by contract for new construction and alteration of existing facilities.

7. Evaluates utility operating and maintenance data.

8. Manages activities to identify, receive, approve, authorize, direct and control work accomplished in-service.

9. Tours CE work centers on a frequent basis, checks for proper use and disposition of materials and equipment and insures shop stocks are not excessive.

10. Directs the activities of the logistics function that manages all base civil engineers.

11. Evaluates quality of service provided to civil engineering customers.

12. Performs quality evaluations on in-process and completed work.

13. Performs labor reporting responsibilities.

Logistics Section.

1. Directs material support activities for all items of supply; is the base civil engineering authority on procedures provided by base supply and procurement activities.

2. Assists Planning and Shops in preparing material requirements.

3. Exercises surveillance over Operations shop in coordination with shop personnel and other supply elements. Conducts periodic bench stock and special level reviews with shop foremen.

4. Processes turn-in of materials and supplies. Determines and enters appropriate cost data.

5. Researches stock numbers, nomenclatures, prices, and data for material requisitioning.

6. Monitors organizational, personal equipment and tool requirements and funding. Maintains listing of equipment and fund requirements by priority of need. Processes equipment and tool requests.

7. Updates the Production Control Center charts to reflect accurate material status information.

8. Maintains WIMs material transactions.

9. Operates Civil Engineering Material Acquisition System (CEMAS).

10. Manages the Due-In From Maintenance Program (DIFM).

Requirements Section.

1. Reviews all work requirements and decides method of accomplishment (in-house or contract).

2. Identifies, receives, processes and plans work to be accomplished by the base civil engineering organization.

3. Directs customer service activities.

4. Programs and manages in-service work through the In-Service Work Plan, scheduling, and customer service.

Production Control Unit.

1. Receives all requests for work to be performed by the base engineering organization either with in-services forces or by contract.

2. Approves work requests or obtains approval by appropriate authority.

3. Determines method of work accomplishment for in-service work. Refers requirements which are selected for facility project accomplishment to the Engineering and Construction Branch.

4. Prepares and maintains In-Service work orders.

5. Processes all job orders in a single functional activity.

6. Operates a service call unit within the Customer Service Unit to receive verbal requests for work and to control rapid response service Do-It-Now vehicles.

7. Operates a Production Control Center which serves as a communications center and unit command post for base level Civil Engineering.

Planning Unit.

1. Collaborates with Production Control in preparation of work orders and job orders prepared by planning.

2. Inspects facilities for maintenance and repair requirements.

3. Makes on-site investigations of proposed work to determine layout, measurements, material, equipment and other essential data.

4. Prepares cost estimates for in-service work requests.

5. Applies automated engineered performance standards in the planning and estimating of jobs.

6. Prepares and maintains the periodic facility survey schedule and coordinates with Operations' work centers and shops.

Structures Section.

1. Performs structural maintenance and repair and masonry work.

2. Performs protective coating work.

3. Performs plumbing work on real property facilities and installed equipment.

4. Fabricates, repairs, welds, and installs sheet metal and metal components.

5. Supports maintenance and repair of aircraft arresting systems.

6. Accomplishes predetermined minor maintenance and repair on high use facilities on a recurring basis with multicraft Structural Maintenance and Repair Teams (SMART).

Electrical Section.

1. Maintains, installs and repairs interior electrical systems.

2. Maintains, installs and repairs primary and secondary distribution systems, exterior lighting, airfield lighting systems and cathodic protection systems.

3 Maintains, installs and repairs electrical appliances.

4. Repairs electric components.

5. Maintains, installs, repairs, adjusts and calibrates all instruments and controls which are a component of real and installed property.

Systems Management Section.

1. Operates EMCS console which provides systems surveillance and control.

2. Maintains and repairs instruments and controls which are components of real property systems.

3. Maintains electronic systems either by contract or in-service capability as appropriate.

Pavements and Grounds Section.

1. Performs pavement maintenance, repair and contruction.

2. Operates contruction and special purpose equipment.

Mechanical Section.

1. Operates, maintains, installs and repairs refrigeration, air-conditioning, evaporative cooling, heat pumps, ice manufacturing plant equipment, cold storage plant equipment and systems, heating plants and systems.

2. Installs, maintains, and repairs petroleum, oil and lubricants and liquid oxygen systems.

3. Maintains, installs, adjusts, repairs and calibrates all pneumatically and hydraulically operated instruments and controls other than that provided by PMEL (7:85-10).

Appendix B: PAT Team Leader Duties

1. PAT members will select a team leader. The team may elect to rotate leadership among the PAT members.

2. Team leaders abide by the PAT guidelines and support the team's consensus decisions. The PAT leader should guide but not dictate or unduly influence teamwork.

3. Team leaders must ensure that the team operates productively and in harmony.

4. Team leaders chair the meetings, maintain order, give guidance to the group, and ensure that all members actively participate. Vote only to break ties.

5. Team leaders should reinforce and encourage member's positive contributions. Give praise, credit, and seek recognition for the team.

6. Team leaders report significant progress, problems, plans, requirements, as appropriate, to the facilitator.

7. Team leaders consider meeting to be essential. They do not postpone, cancel, or fail to meet with the team except on rare occasions of higher conflicting priority. In such a case, a chairperson to act as the team leader temporarily should be assigned.

8. Team leaders inform the facilitator and make recommendations to the Squadron Quality Committee to disband the team if it does not continue to be productive.

9. Team leaders strive to build teamwork, do not show favoritism to particular members, encourage total involvement, support the team's consensus, and promote the personal growth of all the members.

10. Team leaders keep the facilitator advised of team progress, needs, and problems.

11. The team leader will inform the facilitator if he feels unsuited to perform or continue in the role.

Appendix C: QC/PAT Meeting Minutes

1. Date: _____

2. Time: _____

3. Recorder: _____

4. QC PAT (Circle one)

5. QC/PAT Name: _____

6. Attendees:

	Members	Facilitators/Guests
(Leader)	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____

7. Old Business: _____

_____

_____

_____

_____

_____

_____

_____

8. New Business: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

9. Next Meeting:
   Date: _____ Time: _____

Appendix D: Contract For Employee Involvement Groups

1. Group goals:_____

2. Group meetings: Day of week:_____ Frequency:_____

Starting time:_____ Ending time:_____

3. Group size: minimum_____ maximum_____

Group membership is open to:_____

4. Topics for discussion within the group:

Appropriate	Not Appropriate

5. Leadership role: Leadership in the group is:

_____

6. Group decisions made by:_____

_____

7. Group disciplines agreed upon:_____

_____

8. Group norms agreed upon:_____

_____

_____

9. Responsibility for insuring adherence to group norms resides with:_____

10. This contract will be re-negotiated every:_____

name:_____ date:_____

Note: this worksheet was presented by Nympha Clark and Virgil Rehg at the IAQC Fall Conference, Orlando, Fl., Oct 1986.

Appendix E: Process Action Team Problem Solving Process

STEP	TOOLS THAT APPLY*
1. Problem Identification and Selection.	
A. Brainstorm Problems.	Brainstorming
B. Select Top Five.	Consensus Decision Making or Weighted Voting
C. Select Top Problem.	Pareto Analysis and/ or Priority Ranking
D. Write Flow Chart For process.	Flowcharting
E. Problem Statement.	Data Collection
2. Develop a Base Line Measure.	Brainstorming Data Collection
3. A. Identify Problem Causes.	Cause & Effect Diagram
B. Select Most Likely Causes.	Data Collection
4. Investigate Causes.	Data Collection Data Analysis
5. Establish Goals.	Checksheet
6. Develop a Solution.	Priority Ranking
7. Establish Controls.	Priority Ranking
8. Get Approval To Implement.	Checksheet
9. Implement the Solution.	Checksheet
10. Evaluation.	Checksheet
11. Standardization.	Checksheet
12. Present Process To. Management	Checksheet

* Brainstorming and Consensus Decision Making are Usually Used With Each Step in the Problem Solving Process.

Appendix F: Summary of the Primary Duties of the Facilitator

1. Ensure that the team members are trained in the Quality Program Philosophy and the use of problem solving tools and techniques.

2. Monitor team meetings to ensure progress, productivity, and operation in accordance with the PAT guidelines and Squadron Quality Committee direction.

3. Guide, advise, and critique team members in procedures and methods for conducting an effective Process Action Team.

4. Act as liason between the team and the Squadron Quality Committee, when necessary, to request assistance or information.

5. Advise the team on statistical methods, information sources, analysis methods, and process control.

6. Assist the PAT with scheduling meetings and meeting rooms and maintaining meeting meeting rosters. Schedule presentations and special award meetings as necessary.

7. Invite appropriate management, supervision, and Squadron Quality Committee members to PAT presentations.

8. Assist the PAT with arranging for necessary and appropriate materials such as overhead projectors and flip charts.

9. Assure that PAT records are maintained relevant to the team's achievements, long-term statisitics, and projects.

10. Report pertinent, critical, and significant factors to the Squadron Quality Committee.

11. Substitute for team leaders in their absence.

Appendix G: Quality Questionnaire

The following sections will ask for information about from you about your organization. Please answer each question to the best of your abilities on a separate sheet of paper. For example, the primary intention for the following section on leadership is to determine if your organization's leadership emphasizes quality as part of the company's value system, through both personal action and through demands on employees. Use the following scale to rate all questions.

1 = Strongly disagree
2 = Moderately disagee
3 = Slightly disagree
4 = Neither agree nor disagree
5 = Slightly agree
6 = Moderately agree
7 = Strongly agree

PREFACE: The intent of this questionnaire is to query individuals who have been intimately involved with the CE PATs and those who have not, then to note significant differences.

I. LEADERSHIP

A. Supervisory Communication

1. Your supervisor encourages you to let him/her know when things go wrong on the job.

2. The communication between you and your supervisor is good.

3. You are free to tell your supervisor that you disagree with him/her.

4. Work center problems are often discussed as a group, with supervisors and workers openly and honestly discussing the issues.

5. Your supervisor is fully aware of work center problems.

B. Participative Decision Making

1. This organization is always moving toward the development of new answers.

2. In your organization, people are allowed to try to solve the same problem in different ways.

3. Creativity is encouraged in your organization.

4. People in your organization are always searching for fresh, new ways of looking at problems.

5. The leadership acts as if people in your organization are creative.

C. Commitment to Quality

1. Quality is more than just the latest fashionable "buzzword".

2. Your boss is sincerely interested in giving you time to do the job right.

3. Product defects are an unwanted, but inevitable by-product of deadlines and schedules.

4. Your supervisor tries hard to remove restrictions that limit performance.

D. Shared Vision

1. Continually improving work results are a realistic goal.

2. Our organization continually works to improve overall end results.

3. When we work to increase quality, we don't necessarily decrease productivity.

II. STRATEGIC QUALITY PLANNING

A. Goal Clarity

1. You know exactly what is expected of you in performing your job.

2. You understand the priorities associated with what you are expected to accomplish on the job.

3. Your supervisor clearly indentifies those work processes that need improvement.

B. Goal Congruence

1. Your organization's goals make a lot of sense.

2. You have a personal stake in your organization's effectiveness.

III. HUMAN RESOURCE MANAGEMENT

A. Training Adequacy

1. You have all the skills you need in order to do your job.

2. You have been provided enough training to acquire the necessary skills to do your job well.

B. Involvement

1. You feel personally responsible for the work you do on your job.

2. You often make suggestions for improving work conditions and processes.

3. Management encourages, and often discusses with the work force new ideas for improving how jobs are done.

C. Empowerment

1. Rules and regulations of your organization are not meant to hinder your performance.

2. Your ideas for improving work conditions and processes are often implemented.

3. You are given opportunities to provide your own ideas to try to improve "the way things are done" in your organization.

D. Expectancy

1. Your supervisor consistently rewards top performers.

2. The people who most deserve recognition receive that recognition.

E. Role Clarity

1. You know exactly what is expected prior to undertaking any specific task.

2. You know who makes the decisions in your organization and how the decisions are reached.

F. Recognition/Feedback

1. Your least frequent feedback is criticism.

2. Your supervisor provides immediate feedback when work results are good.

3. You usually know whether or not your work is satisfactory.

IV. QUALITY ASSURANCE OF PRODUCTS AND SERVICES

A. Quality system

1. You have no problem obtaining the tools, equipment and supplies necessary to do your job.

2. You are held accountable for your mistakes and are required to take action to prevent their recurrence.

3. This organization attempts to solve its problems as best it can.

V. QUALITY RESULTS

A. External Measures

1. Your organization is as good as any other similar organization.

2. Complaints are rarely ever received about the work of your organization.

3. The results of work in your organization meet your customers standards.

B. Internal Measures

1. Your organization is the best it has ever been.

2. In your organization everyone knows how important it is to do things right.

VI. CUSTOMER SATISFACTION

A. Responsiveness

1. Your customers have the right to talk to the person who did the work if they are unhappy about it.

2. If a customer complains about something, immediate action is taken to identify the problem.

3. Customer satisfaction is the whole reason we work for-- the phrase "satisfying our customers" receives more than just "lip service" in our organization.

4. Customers are given the fastest possible feedback to their questions.

5. It is easy for the customer to get in contact with the experts.

6. Customers receive courteous treatment from your organization.

B. Feedback

1. The most important measures of your performance are obtained through customer feedback.

2. You always receive information on our customers reactions when it involves your work.

3. In this organization, you often make changes based on inputs from your customers.

Thank you for your help in this endeavor.

If you have any constructive comments regarding improvement of your quality program, please indicate these for consideration by your organization.

Appendix H: Performance Award Checksheet

-- The individual's appraisal reflects that an award is warranted when compared to your other employees' appraisals.

-- Justification for this award is based on performance during the entire year.

-- You have no other employees who are more deserving of this award, regardless of who received awards last year.

-- This employee is definitely a BCE team member.

-- This employee represents the squadron well to customers.

-- This is one of your best employees.

-- This award is not being given to avoid a complaint.

-- This employee performs with exceptional accuracy, thoroughness and effectiveness.

If any of the above statements cannot be answered in the affirmative-----this employee may not deserve a performance award.

Appendix I: Affected and Control Group Means and T-Test Results

QUESTION	MEAN A	MEAN B	t-VALUE	p-VALUE	REJECT NULL
1	6.4	5.1	4.95	.0024	YES
2	6.4	5.5	3.16	.0025	YES
3	6.2	5.1	4.52	.0000	YES
4	6.23	4.03	7.63	.0000	YES
5	5.66	4.63	3.29	.0017	YES
6	5.6	4.53	3.37	.0013	YES
7	6.0	4.23	4.98	.0000	YES
8	5.93	4.83	2.89	.0054	YES
9	5.97	4.97	2.72	.0087	YES
10	5.47	4.37	2.56	.0131	YES
11	5.93	4.36	3.81	.0003	YES
12	6.2	4.2	6.45	.0000	YES
13	4.1	5.3	3.45	.0011	YES
14	5.83	4.77	2.83	.0070	YES
15	5.96	5.47	1.59	.1181	NO
16	5.96	5.23	2.41	.0190	YES
17	6.1	5.2	2.63	.0112	YES
18	6.07	4.73	3.72	.0005	YES
19	5.7	5.13	1.63	.1102	NO
20	5.8	4.23	4.4	.0001	YES
21	5.87	4.13	6.55	.0000	YES
22	6.2	4.9	5.24	.0000	YES
23	5.67	4.33	5.29	.0000	YES
24	5.97	4.16	6.21	.0000	YES
25	6.37	5.1	3.9	.0003	YES
26	6.47	5.00	3.93	.0003	YES
27	6.13	5.17	3.05	.0036	YES
28	5.9	4.33	6.21	.0000	YES
29	5.97	5.07	3.2	.0024	YES
30	5.63	4.5	3.15	.0026	YES
31	5.93	4.23	6.12	.0000	YES
32	5.73	4.23	5.10	.0000	YES
33	5.63	4.63	2.76	.0077	YES
34	5.47	4.1	3.56	.0007	YES
35	5.6	4.03	4.71	.0000	YES
36	5.83	5.1	2.27	.0271	YES
37	5.6	4.23	3.56	0008	YES
38	5.73	4.76	2.49	.0157	YES
39	5.67	4.86	2.23	.0298	YES
40	5.9	4.3	4.79	.0000	YES
41	5.93	5.5	1.58	.1193	NO
42	5.27	5.0	.63	.5338	NO
43	5.2	5.03	.40	.6874	NO
44	5.97	5.5	1.40	.1664	NO
45	5.67	4.83	2.17	.0345	NO

46	5.83	4.80	2.51	.0147	YES
47	6.20	5.00	4.15	.0001	YES
48	5.83	4.83	2.81	.0068	YES
49	6.23	5.27	3.59	.0007	YES
50	5.43	4.41	3.63	.0006	YES
51	6.1	5.1	3.49	.0009	YES
52	5.87	5.13	2.24	.0287	YES
53	5.87	5.10	2.56	.0132	YES
54	5.43	4.30	3.35	.0014	YES

Bibliography

1. Air Force Logistics Command. "Hansen To Suppliers: AFLC Buys Best Value," Skywriter, 30: 23 June 89.

2. Air Force Logistics Command. Continuing Quality Program Development. Unpublished policy letter. HQ AFLC/CC, Wright-Patterson AFB OH, February 1989.

3. Air Force Logistics Command. 2750th Air Base Wing Quality. Unpublished Program Plan. Wright Patterson AFB OH, 1987.

4. Air Force Logistics Command. Total Quality Management Plan. Wright Patterson AFB OH, 17 Mar 1988.

5. Burstein and Sedlak, "The Federal Quality and Productivity Improvement Effort," Quality Progress, 10: 39-41 (October 1988).

6. Butterfield, Ronald W. "A Quality Strategy for Service Organizations," Quality Progress, 12: 40-42 (December 1987).

7. Cascio, Wayne F. Applied Psychology In Personnel Management. Englewood Cliffs: Prentice Hall, Inc., 1987.

8. Deming, W.E. Designing Organizations That Work: An Introduction To Sociotechnical Systems. North Hollywood CA: John J. Cotter & Associates, 1983.

9. Department of the Air Force. Civil Engineering-General: Operation and Maintenance of Real Property. AFR 85-10, Washington: HQ USAF, 24 Oct 1975.

10. Department of the Air Force. Civil Engineering Operations and Maintenance Branch. AFR 85-2. Washington: HQ USAF, October 1988.

11. Department of the Air Force. Civil Engineering Operations and Maintenance Branch. AFR 85-10. Washington: HQ USAF, October 1975.

12. Department of Defense. Total Quality Management, DOD 5000.51. Office of the Deputy Assistant Secretary of Defense for TQM, OASD(P&L)TQM, Washington DC, February 1989.

13. Department of Defense. Total Quality Management Guide For Implementation. DOD 5000.51G. Office of the Deputy Assistant Secretary of Defense for TQM, OASD(P&L)TQM, Washington DC, February 1989.

14. Department of Defense. Total Quality Management Master Plan. Office of the Deputy Assistant Secretary of Defense for TQM, OASD(P&L)TQM, Washington DC, August 1988.

15. Department of Defense. Total Quality Management. Office of the Deputy Assistant Secretary of Defense for TQM, OASD(P&L)TQM, Washington DC, August 1988.

16. Devore, Jay L. Probability and Statistics for Engineering and the Sciences. Monterey: Brooks/ Cole Publishing Company, 1987.

17. Dockstader, Steven L. "Japanese Quality Control: Implications for Job and Organization Design," Human Factors in Organizational Design and Mangement, North-Holland: Elsevier Science Publishers B.V. 1986.

18. Eddings, Maj James A. and Maj Newhall, Frederick C. Handbook For Civil Engineering Middle Managers. Thesis, Air Command and Staff College, Maxwell AFB AL 1980.

19. Emory, William C. Business Research Methods. Homewood IL: Erwin Publishing Co., 1985.

20. Hacquebord, Heero and Scholtes, Peter R. "Beginning the Quality Transformation, Part I," Quality Progress, 7: 28-33 (July 1988).

21. Hacquebord, Heero and Scholtes, Peter R. "Beginning the Quality Transformation, Part II," Quality Progress, 8: 44-48 (August 1988).

22. Hansen, Alfred G. Speech: "QP4 In AFLC." Given to Air Force Association and Society of Logistics Engineers, Wright-Patterson AFB OH, 1 Sept 1988.

23. HQ USAF/ACM. "A Guide For The Development of the Attitude and Opinion Survey." Washington DC, October 1974.

24. Kachigan, Sam Kash. Statistical Analysis. New York: Radius Press, 1986.

25. Kacker, Raghu N. "Quality Planning for Service Industries," Quality Progress, 8: 39-42 (August 1988).

26. Lyons, Paul E. "Shaving Inventory and Growing Responsive With JIT," Quality Progress, 16: 25-28 (June 1989).

27. Ott, Lyman. An Introduction To Statistical Methods and Data Analysis. Boston MA: PWS-Kent, 1988.

28. Pasmore, W.A. and Sherwood, J.J. Sociotechnical Systems: A Sourcebook. San Diego CA: University Associates, Inc., 1978.

29. Pincinse, Capt. Michael L., Commander, 3800 Civil Engineering Squadron. Personal interview. Wright-Patterson AFB OH, 20 Nov 1988.

30. Puri and McWhinnie, "Quality Management Through Quality Indicators: A New Approach," Quality Assurance. Dearborn Michigan: Society of Manufacturing Engineers, 1981.

31. Rosseau, D.M. "Technological Differences In Job Characteristics, Employee Satisfaction and Motivation: A Synthesis of Job Design, Research, and Sociotechnical Systems Theory," Organizational Behavior and Human Performance, 19: 18-42 (1977).

32. Sarazan, J. Stephen. "Quality Plan Development: A key Step Toward Customer Enthusiasm," Quality Progress, 21: 72-75 (October, 1988).

33. Schneier, Craig E. Personnel Administration. Massachusets: Addison-Wesley Publishing Co., 1982.

34. Simers and others. "Just-In-Time Techniques In Process Manufacturing Reduced Lead Time, Cost; Raise Productivity, Quality," Industrial Engineering, 21: 16-23 (January 1989).

35. Spechler, Jay W. When America Does It Right. Norcross Ga.: Industrial Engineering and Management Press, 1988.

36. Store, Eugene F. Research Methods in Organizational Behavior. Glenview Il.: Scott, Foresman and Company, 1978.

37. Walizer, Michael H. and Wiemer, Paul L. Research Methods and Analysis. New York: Harper and Row, 1978.

38. Westland, Cynthia Lane. "Avoid the Just In Time Errors," Quality Progress, 21: 69-70 (October, 1988).

39. Wricklan, M. "Obtain CE Management Commitment to the AFLC Quality Program." Unpublished memorandum from DEI to BCE, Wright-Patterson AFB OH, Feb 20, 1989.

Vita

1st Lt. Robert M. Wertz [redacted] He graduated from high school in 1981. Next, he attended the State University of New York at Buffalo where he was awarded a Bachelor of Science in Mechanical Engineering in 1985. Upon graduation, he recieved a commission in the USAF through the Officer Training School program and was assigned to the Maxwell AFB Civil Engineering Squadron as a mechanical design engineer. In addition to his design tasks, he was chief of the mechanical PRIME BEEF teem at Maxwell AFB.

In 1988, 1Lt Wertz was sent to Wright Patterson AFB to attend the School of Systems and Logistics, Air Force Institute of Technology.

[redacted]

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public release; Distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GEM/LSM/89s-19	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION School of Systems and Logistics 6b. OFFICE SYMBOL (*If applicable*) AFIT/LSM	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (*City, State, and ZIP Code*) Air Force Institute of Technology Wright-Patterson AFB OH 45433-6583	7b. ADDRESS (*City, State, and ZIP Code*)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (*If applicable*)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (*City, State, and ZIP Code*)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (*Include Security Classification*)

DESIGN AND IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT IN A CIVIL ENGINEERING SQUADRON

12. PERSONAL AUTHOR(S)
Robert M. Wertz, B.S., 1st Lt, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (*Year, Month, Day*)	15. PAGE COUNT
MS Thesis	FROM _____ TO _____	1989 September	130

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUB-GROUP	
13	08		Total Quality Management, Quality Assurance

19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

Thesis Advisor: Hal Rumsey
Associate Professor
AFIT/LSG

Approved for public release: IAW AFR 190-1.

Larry W. Emmelhainz

LARRY W. EMMELHAINZ, Lt Col, USAF 11 Oct 89
Director of Research and Consultation
Air Force Institute of Technology (AU)
Wright-Patterson AFB OH 45433-6583

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Maj Hal Rumsey, Associate Professor	22b. TELEPHONE (*Include Area Code*) (513) 255-5023 / 22c. OFFICE SYMBOL LSG

DD Form 1473, JUN 86 *Previous editions are obsolete.*

The purpose of this study was to examine and document Total Quality Management (TQM) in a Civil Engineering squadron to improve quality and productivity of services and goods produced. This study was meant to provide a model of TQM implementation, as well as lessons learned, which would be useful to any other governmental organization (especially a Civil Engineering squadron) who desires organizational quality and productivity improvements.

In addition to the case study, a "Quality Questionnaire" survey was administered to employees at all levels to determine quality perception changes which occurred due to the TQM implementation. The study found that, out of 6 main categories measuring quality, 5 of the 6 showed statistically significant inmprovements in the employees' perceptions of organizational quality. In fact, the only category which failed to demonstrate an increase was "Internal and External Quality Results"; however, this could have been expected, since the TQM process improvements have improved quality and efficiency of processes, but not enough time has passed to actually observe significant changes in product quality.

TQM stresses employee participation-- something that Japan has been successful with for decades, while actual participative management is still in its infancy in American industrial and governmental functions. This study reported several gains from employee participation in improving all work processes. Indeed, tapping the creative intelligence and expertise of hundreds throughout a field demonstrated the potential to vastly streamline processes, increasing the quality of goods and services produced by the company.